VEOLIA WATER CENTRAL

Adapting to Climate Change

A report to Defra and the Secretary of State in response to a direction to report under the Climate Change Act 2008

January 2011

Prepared By: Andrew Makinson

andrew.makinson@veoliawater.co.uk

Veolia Water Central
Tamblin Way
Hatfield
Hertfordshire
AL10 9EZ

NOTE

This document has been compiled in order to comply with the new requirement to report our climate change adaption strategy to DEFRA. The format of the executive summary of this report is as specified in the evaluation guidelines issued by Cranfield University

EXECUTIVE SUMMARY

1. Information on organisation	
Name of organisation	Veolia Water Central Limited
Organisation's functions, mission, aims, and objectives affected by the impact of climate change	We are a water only supply company operating in the South East of England. We provide public water supplies to a population of 3.2 million in 1.1 million households and commercial businesses in Home Counties to the North and West of London As a water services company, our business operations are intrinsically linked to the weather. Our functions which we believe may be affected by climate change are: *Managing Water Resources Sustainably*: Sustainable water management is at the heart of our business. Our job is to ensure that supplies of water to our customers remain secure and of the highest quality with least effect on our environment. *Meeting Future Demand for Water:* We have a duty to provide sufficient quantities of water to meet the demands of all our customers. We work to reduce the increase in future demand for water through water efficiency operations, reducing leakage, and providing information to our customers on the importance of saving water. *Providing Water Which Meets Drinking Water Inspectorate Standards*: We are committed to providing safe, high quality drinking water for our customers. We do this by operating and maintaining our assets diligently along with sampling and testing the quality of the water we supply. We aim for 100% compliance in treated water quality and achieved 99.98% last year. *Providing a Reliable Network Infrastructure which Adheres to Regulation:* We have over 14,000 kilometres of underground pipes and in our most populated regions they lie in an aggressive London Clay soil environment which is prone to movement from shrinkage and expansion. These pipes are sensitive to adverse weather conditions.

2. Business preparedness before Direction to report was issued.	
Has your organisation previously assessed the risks from climate change?	We have assessed the risks from climate change as part of our Water Resources Management Plan, Drought Management Plan and Business Plan. Climate change is just one of the strategic risks accounted for in our planning. We also undertake research to assess the risk of climate change across sections of our business which are not fully understood. Examples of this include research to quantify the effect climate change may have on the quality of our raw water resources.
If so, how were these risks and any mitigating actions incorporated into the operation of your organisation?	Our statutory functions, powers and duties are established in UK law through relevant legislation principally the Water Industry Act 1991 and its subsequent amendments. The UK water industry is highly regulated through a number of organisations including: • Ofwat (The Water Services Regulation Authority) the economic regulator of the water and sewerage sectors in England and Wales. • The Environment Agency are responsible for protecting the environment and provide Guidelines for producing Water Resources Management Plans and Drought Management Plans. • The Drinking Water Inspectorate who continually monitor the quality of the water that supplied to ensure that it complies with EU and UK standards. • The Health and Safety Executive within the workplace. • Non-government agencies, including consumer organisations and environmental stakeholders, also play a large part in informing water policy and practice across the sector. Amongst other regulatory submissions, we are required to prepare and submit Business Plans to Ofwat and, Water Resources Management Plans and Drought Management Plans to the Secretary of State to explain our proposals for securing and maintaining supplies of water over a 25 year planning horizon. The process of preparing and submitting these documents has enabled us to assess the impact of, formulate action plans for, and secure funding to enact climate adaptation measures. The Plans are reviewed and updated annually between regulatory submissions.

3. Identifying risks due to the impacts of climate change	
What evidence, methods, expertise and level of investment have been used when investigating the potential impacts of climate change.	Our approach to investigating the potential impacts of climate change differs according to risk factor and the following methods have been used. In all cases UKCP09 projections of future climate change have been used as the standard climate change forecast: *Water scarcity*. A number of studies have been carried out including forecasts of the amount of water available to meet the demand of our customers until 2035. We are able to quantify effects on both our future supply capability and customer demand and these are combined to assess any actions needed to maintain security of supply. This work culminated in our Water Resources Management Plan and Drought Management Plan. *Flood Risk.* Flood risk mitigation requires substantial capital expenditure and is addressed by our Business Plan. Our recent flood risk studies were undertaken by independent consultants Jacobs to identify potential sites at risk, quantify the threat and design adaption measures. *Reduction in Network Resilience.* To assess the potential impact of climate change on burst rates, we have evaluated historical data to produce a qualitative review of this risk. This data is analysed in our Business Plan and as part of the demand management options appraisal in our Water Resources Management Plan. To assess the risk posed to our administrative capacities we have consulted published data on the effect climate change may have on the ICT and transport sectors and quantified its impact on our operations.

4. Assessing risks	
How does your organisation quantify the impact and likelihood of risks occurring?	Our risk register characterises risks using a severity/likelihood matrix allowing for easy identification of areas requiring action. Likelihood is scaled from "(1) Low" to "(4) High" with severity scaled similarly – "(1) Low", "(4) Very Serious". These scores are multiplied resulting in a potential risk rating of between 1 and 16. *Water scarcity.* We quantify the future supply/demand balance and also assess their uncertainty. First future water resource availability is calculated by evaluating the results of a number of studies detailed in our Water Resources Management Plan. Secondly, future demand levels are forecast assessing ownership, frequency and use of water using appliances and behaviours and by combining estimates of the effect of water

	efficiency with future population forecasts. To account for uncertainty and flexibility, a 'headroom' margin is applied to the supply demand balance. *Flood Risk*. We commissioned consultants Jacobs to assess the effect flooding may have on our water production sites. This study quantified the level and frequency needed for a flood to cause damage and/or loss of supply. *Reduction in Network Resilience.* Reduction in network resilience is more difficult to quantify and requires more qualitative and expert analysis of the risk. Where possible, historical data has been used and results from other studies.

5. Uncertainties and assumptions	
What uncertainties have been identified in evaluating the risks due to climate change?	Uncertainties identified during the compiling of this report are explained in detail in Section 6. *Legal and regulatory uncertainties*: Our legal and regulatory responsibilities will evolve over time and we will face new challenges that may affect our plans for climate change adaption. *Financial uncertainties*: Future funding and thus investment is subject to future price regulation and the views of our customers on the services and uncertainty we provide. *External data reliability*: We have used a range of external data sets such as the UKCP09 projections as well as flood maps from the Environment Agency. These data are the most accurate available but with all forecasts, an element of uncertainty remains. We have allowed for a level of uncertainty in our planning where the scale of risk has been assessed. *Water quality*: We are aware that climate change may affect the quality of our raw water resources however this is uncertain. We have identified this area for further research. *Effects of climate change*: The scale of UKCP09 projections are based on a range of global weather models with inherent uncertainty accordingly the frequency and severity of extreme weather events are difficult to accurately predict.
What assumptions have been made?	We have assumed that external data and projections are accurate but included an assessment of uncertainty in our analysis. We also assume that future financial, regulatory, and legal circumstances will remain relatively unchanged and that our business functions will not be significantly different within our

	planning horizon. For example, we assume that our operational area and business model remains constant and that we will continue to be fully funded to fulfil our regulatory obligations and targets.

6. Addressing current and future risks due to climate change - summary

BUSINESS FUNCTION	*CLIMATE VARIABLE*	*PRIMARY IMPACT OF CLIMATE VARIABLE*	*THRESHOLDS ABOVE WHICH THIS WILL AFFECT BUSINESS*	*LIKELIHOOD OF THRESHOLDS*	*POTENTIAL IMPACTS ON ORGANISATION AND STAKEHOLDERS*	*PROPOSED ACTION TO MITIGATE IMPACTS*	*TIMESCALE OVER WHICH RISKS ARE EXPECTED TO MATERIALISE AND ACTION IS PLANNED*
Managing water resources sustainably	Variation in precipitation	Reduction in ground and surface water levels.	1.9 – 2.5% reduction in long term water availability due to climate change.	Dependant on data reliability – presumed very accurate. Demand plus headroom higher than supply at peak by end of planning horizon.	Reduced network resilience/stability, reduced supply capabilities, increased reliance on emergency supplies, unpredictable supply, costs associated with locating/exploiting new sources, unstable supply/demand balance.	Ensure supply exceeds demand, water efficiency operations including leakage operations, improve network efficiency, promotion of water efficiency behaviour including increased metering, regular review of the WRMP, explore options for increasing supply, import water from elsewhere to meet demand, improve supply resilience.	Current strategy fit for purpose until 2035 on average or 2026 at peak demand.
		Potential increase in drought frequency.	Compulsory usage restriction: 1 in 10 year event	Maximum likelihood of 1 in 10 years. Currently realistically around 1 in 15 years.	Increased operation costs, reduced network resilience and reliability, increased regulatory restriction, reliance on emergency supplies, water shortages, compulsory usage restrictions.	Numerous water efficiency operations, regular review of drought plan, potential for increased storage, efforts to reduce demand, drought planning, lobbying for change in regulations and control over appliance installation.	Unknown: risk may materialise over many decades – regular review of WRMP and drought plan necessary. Current work ongoing – action planned, to various degrees, over planning horizon.
Meeting future demand for water	Increase in temperature	Warmer weather leading to increased demand.	At current rates, demand including headroom will overtake supply by 2026 at critical and 2035 at average consumption.	Demand levels accurately predicted to rise due to confirmed house building projects in region. Likelihood of increase in temperature unknown – however if rise in temperature is experienced – rise in demand very likely.	Increase costs to customer, water shortages, bad publicity, increased reliance on emergency supplies, necessity to invest in expensive projects to meet demand, strain put on supply/demand balance.	Ensure supply exceeds demand, water efficiency operations including leakage operations, improve network efficiency, promotion of water efficiency behaviour, regular review of drought plan, explore options for increasing supply, import water from elsewhere to meet demand, improve supply resilience.	Planning to 25 year horizon. Current strategy fit for purpose until 2035 on average or 2026 at peak demand. Continual updating and review of WRMP and drought plan necessary.
	Flooding	Loss of/damage to physical assets required to deliver water	Potentially 1 in 100 year plus 20% flow event at best case scenario. For selected sites – 1 in 20 year event.	Maximum of 1 in 400 probability Minimum of 1 in 20 probability.	Loss/degradation of supply as well as increased reliance on emergency supplies.	Increased storage, raising of plant equipment, analysis of localised effects of flooding, increase network resilience	Unknown: risk may materialise over many decades. Current work due for completion by 2015 will raise resilience to 1 in 400 year event.
Providing a reliable network which adheres to regulation	Variable temperature	Shrinkage and swelling of ground due to variations in temperature increasing incidence of leaks.	Unknown	Unknown although evidence shows correlation between temperature fluctuation and bursts.	Increased burst rate, disruption due to fixing, associated financial, energy, and carbon costs of repair, Cost and disruption of increased replacement of network. Increased water wastage, potential for supply to not be sufficient due to leakage.	Continued replacement of network, continued efforts to reduce pressure in network, providing alternative methods of asset delivery, improvements in monitoring and prediction so that leaks can be found and fixed quickly, environmental accounting to justify investment.	Adherence to ELL until cost of repair outweighs cost of replacement. Timescale not currently definable.

7. Barriers to Implementing adaptation programme	
What are the main barriers to implementing adaptive action?	*Regulation and Legislation*: Many of our regulatory requirements are not conducive to a climate change adaptation programme. For example, our financial regulation structure makes justification of long term projects difficult with a relatively short 5 year Business Planning cycle. We propose to work closer with our regulators to resolve these issues. *Resources:* We may find ourselves in a situation where adaptation actions have been identified but investment has not been included within price limits for the near future eg. compulsory metering. As a result we are unable to devote resources to ensure successful completion of the programme. This is a problem all companies will face and we will have to develop a new framework to evaluating the costs and benefits for projects specifically aimed at adapting to climate change. *Knowledge*: Uncertainties in many areas are preventing us from acting. Devoting substantive resources on projects based on qualitative or indicative data is unwise. With more information on the specific effects of climate change, we can create specific adaptation actions which we are sure are appropriate. We will continue our research and collaboration with relevant authorities to overcome this.
Has the process of doing this assessment helped you identify any barriers to adaptation that do not lie under your control?	*Interdependencies and Stakeholders*: We must justify our operations not only to our regulators but to our customers and other relevant stakeholders also. For example, we may not justify projects to improve water quality if the out come of this project is detrimental to the environment. We also rely heavily on other sectors, for example energy production and transport. If these sectors are unprepared then these may undermine our adaption actions. To overcome this we will continue to liaise with all relevant stakeholders and interdependencies and aim to work together to overcome barriers.

8. Report and review	
How will the outcome of the adaptation programme be monitored and evaluated and what is the timetable for this?	We monitor the outcome of our projects and report these annually in regulatory returns. We prepare Plans for submission to our financial regulator on a 5 yearly basis and we consult on and prepare Water Resources Management Plans that includes assessment of investments needed to adapt to accommodate climate change effects for approval by the Secretary of State. These Plans are monitored and updated annually.
How do you propose to monitor thresholds above which impacts pose a threat to your organisation (including the likelihood of these thresholds being exceeded and the scale of the potential impact)?	Where current thresholds are known, we will continue to monitor these and report via our Plans. Where thresholds are currently unknown, our periodic monitoring will ensure that when this information becomes available we will be in a position to act on it.
How will the benefits of the programme be realised and how will this feed into the next risk assessment and options appraisal?	When we begin to experience the benefits from our proposed adaptation actions, we will report these back through our relevant Plans. This information will then feed into our corporate risk register which is continually updated. If and when additional issues arise, these will be assessed and added to the risk register. Monitoring of this will take place and be reported on in our Plans.
How have you incorporated flexibility into your approach?	We have built resilience into our operations to preserve security of supply to our customers, for example by preparing for flood events of 1 in 100 year flow + 20%. This additional 20% allows for an increased margin of safety to overcome uncertainties in our flood predictions. For water scarcity we have specifically allowed for flexibility in our headroom calculations for our supply/demand balance forecasts. Our constant monitoring and evaluation approach enables us to remain flexible to respond to risks as they materialise.

9. Recognising opportunities	
What opportunities due to the effects of climate change and which the organisation can exploit have been identified?	No opportunities that have the potential to make a noticeable difference on our operations have been identified. If and when opportunities do materialise, these will be reported on in our Plans.

10. Further comments/ information	
Do you have any further information or comments which would inform Defra (e.g. feedback on the process, the statutory guidance, evidence availability, issues when implementing adaptation programmes, challenges etc)?	Climate change adaptation is embedded in our long term investment planning to secure an adequate margin over 25 years between water resource availability and demand for water. However although we anticipate that water resource availability will reduce in future years due to the combined impacts of climate change and implementation of the Water Framework Directive, the current regulatory guidelines for water resource planning prevent us from taking account of a quantity of lost resource beyond 2015 in our investment plans. As result of this we have a small supply/demand surplus and we have been unsuccessful in the short term in persuading our economic regulator that investment in leakage reduction and metering is cost-beneficial. This has created a dichotomy between our Business Plan and our Water Resources Management Plan which has been approved by the Secretary of State. Investment in metering and leakage reduction increase network resilience and reduce environmental impacts by reducing demand for water therefore reducing our requirement to abstract water from streams and aquifers which may be adversely affected by the effects of climate change. We will work closely with our financial and environmental regulators to address this issue in the next period.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I
TABLE OF CONTENTS X
LIST OF FIGURES XII
LIST OF TABLES XIII
1 INTRODUCTION 1
1.1 Climate Change Adaptation 1
1.2 This Report 2
2 WHO WE ARE AND WHAT WE DO 3
2.1 About Veolia Water Central 3
2.2 Veolia Water Central Business Functions 4
2.2.1 Managing Water Resources Sustainably *4*
2.2.2 Meeting Future Demand for Water *4*
2.2.3 Providing Water Which Meets Drinking Water Inspectorate Standards *5*
2.2.4 Providing a Reliable Network Infrastructure which Adheres to Regulation *5*
3 OUR RISK ASSESSMENT APPROACH 6
3.1 Strategic Risk Management Process 6
3.1.1 Phase 1 - Risk Identification *7*
3.1.2 Phase 2 - Risk Assessment *8*
3.1.3 Phase 3 - Risk Control Analysis *12*
3.1.4 Phase 4 - Risk Treatment *13*
4 RISKS TO VWC BUSINESS FUNCTIONS FROM CLIMATE CHANGE 16
4.1 Water Scarcity 16
4.1.1 Summary of Methodology Used *16*
4.1.2 Increased Demand *17*
4.1.3 Reduced Supply *18*
4.1.3.1 Groundwater 20
4.1.3.1.1 Summary of Methodology Used 20
4.1.3.1.2 Potential Impacts of Climate Change 20
4.1.3.2 Surface Water 23
4.1.3.2.1 Summary of Methodology Used 23
4.1.3.2.2 Potential Impacts of Climate Change 23
4.2 Flood Risk 24
4.2.1 Summary of Methodology Used *25*
4.2.2 Potential Impacts of Climate Change *26*
4.3 Reduction in Network Resilience 29
4.3.1 Burst Control *29*
4.3.1.1 Summary of Methodology Used 30
4.3.1.2 Potential Impacts of Climate Change 31
5 PROPOSED ADAPTATION ACTIONS 32
5.1 Adaptation to Water Scarcity 32
5.1.1 Current Actions *32*
5.1.2 Proposed Action to Adapt to the Effects of Climate Change *32*
5.1.2.1 Education 33
5.1.2.2 Water Tariffs 33
5.1.2.3 Metering 33
5.1.2.4 Water Efficiency Operations 34

5.1.2.5 Efficient Management of Supply 35
5.2 Adaptation to Flood Risk 35
5.2.1 Current Actions 35
5.2.2 Proposed Action To Adapt to the Effects of Climate Change 39
5.3 Improving Network Resilience 41
5.3.1 Reducing Impact of Bursts 41
5.3.1.1 Current Actions 41
5.3.1.2 Proposed Action to Adapt to the Effects of Climate Change 42

6 UNCERTAINTIES 44

6.1 Legal and Regulatory Uncertainties 44
6.2 Data Reliability 44
6.3 Water Quality 45
6.4 Effects of Climate Change 46
6.5 Risks to Administrative Operations 47

7 BARRIERS TO ADAPTATION 49

7.1 Regulation and Legislation 49
7.2 Resources 49
7.3 Knowledge 49
7.4 Interdependencies and Stakeholders 50

8 MONITORING AND CONCLUSION 51

8.1 VWC and Climate Change 51
8.2 PACT 51
8.2.1 PACT Framework 52
8.2.2 Veolia Water Central PACT Performance 53
8.3 Moving Forward 54

A. APPENDIX A - CRANFIELD EVALUATION FRAMEWORK: KEY ATTRIBUTES CROSS REFERENCE ..... A

B. APPENDIX B - STATUTORY GUIDANCE TO REPORTING AUTHORITIES: BOX 2 CROSS REFERENCE 8-B

C. APPENDIX C - LIKELIHOOD/SEVERITY MATRIX FOR IDENTIFIED CLIMATE CHANGE RISKS C

LIST OF FIGURES

Figure 2.1.a: Veolia Water Central within the Southeast of England 3
Figure 2.2.a: Diagram showing bursts (pink dots) are more prevalent in grounds characterised by London Clay (brown areas)..... 5
Figure 3.1.a: Veolia Water risk assessment methodology structure 7
Figure 4.1.a: Schematic representation of WRMP Studies 17
Figure 4.1.b: Water supply forecasts with no demand savings from metering - critical period 19
Figure 4.1.c: Water supply forecasts with no demand savings from metering - average period 19
Figure 4.1.d: Distribution of Winter Low Rainfall Events 1853-2005 21
Figure 4.1.e: Supply Forecast including Climate Change 22
Figure 4.2.a: EA Flood map of Walton water treatment works 26
Figure 4.2.b: Flood level plates 26
Figure 4.2.c: Applying flood levels on site using ‘smart’ GPS 27
Figure 4.2.d: Switchgear at risk of flooding 28
Figure 5.2.a: Example of raised Transformer 37
Figure 5.2.b: Example of raised control equipment 37
Figure 5.2.c: A previously raised pump now requiring additional protection to adapt for a climate change scenario..... 38
Figure 5.2.d: Example of a high security access door where a ‘stop plate’ will be installed inside the building, allowing access with security..... 38
Figure 8.2.a: PACT levels of preparedness 52
Figure 8.2.b: Veolia Water PACT performance 54

LIST OF TABLES

Table 3.1.a: Phase 1 - risk identification as seen on the VWC corporate risk register 7
Table 3.1.b: Phase 2 - risk assessments as seen on the VWC corporate risk register 8
Table 3.1.c: Risk Assessment probability classification 8
Table 3.1.d: Risk Assessment severity classification 9
Table 3.1.e: Calculation method for likelihood/severity matrix for risk example 11
Table 3.1.f: Risk Assessment - risk rating matrix 11
Table 3.1.g: Risk Assessment - total risk score guide 11
Table 3.1.h: Phase 3 - risk control analysis as seen on the VWC corporate risk register 12
Table 3.1.i: Phase 4 - risk treatment as seen on the VWC corporate risk register 13
Table 4.1.a: Effect of climate change on ground water resource base assuming no loss of time limited licence 22
Table 4.1.b: Surface Water Sources 24
Table 4.3.a: Total number of repairs 30
Table 4.3.b: Natural Rate of Rise at company and at resource zone levels 30
Table 5.1.a: Costs of reductions in PCC 34
Table 5.2.a: Flood adaptation project summary 40

1 INTRODUCTION

Veolia Water Central Limited is the largest water supply only company in the UK. We supply 860 million litres of water a day to over three million people in parts of Bedfordshire, Berkshire, Buckinghamshire, Essex, Hertfordshire, Surrey, the London boroughs of Harrow and Hillingdon and parts of four other boroughs. We are committed to producing a reliable, safe supply of high quality drinking water to customers; and to ensuring a sufficient and continued supply of water both now and in the future.

Our statutory functions, powers and duties are established in UK law through relevant legislation principally the Water Industry Act 1991 and its subsequent amendments. The UK water industry is highly regulated through a number of organisations appointed by Defra including:

- Ofwat (The Water Services Regulation Authority) the economic regulator of the water and sewerage sectors in England and Wales;
- The Environment Agency responsible for protecting and promoting the environment;
- The Drinking Water Inspectorate who continually monitor the quality of the water that supplied to ensure that it complies with EU and UK standards,
- The Health and Safety Executive within the workplace.
- Non-government agencies, including consumer organisations and environmental stakeholders, also play a large part in informing water policy and practice across the sector.

Amongst other regulatory submissions, we are required to prepare and submit Business Plans to Ofwat at 5 yearly intervals, Water Resources Management Plans and Drought Management Plans to the Secretary of State to explain our proposals for securing and maintaining supplies of water over a 35 year planning horizon. The process of preparing and submitting these principal planning documents has enabled us to assess the impact of, formulate action plans for, and secure funding to enact climate adaptation measures.

1.1 Climate Change Adaptation

Section 61 of the Climate Change Act 2008 gives the Government the power to require Reporting Authorities to prepare and submit Climate Change adaptation reports for the Secretary of State taking into account the reporting guidelines prepared by Defra. As one of around 100 leading organisations we have been required by the Secretary of State to prepare this report detailing:

- How we have assessed that climate change is already impacting, and how it might impact in the future, upon our organisation and,
- Our proposals to adapt to climate change.

The work of UKCIP and others has produced tools and approaches that can help to identify and assess impacts. This combined with our extensive historical data sets and years of reporting and expert analysis mean Veolia Water Central is in a robust position to identify and evaluate potential impacts and propose actions to adapt to the emerging risks associated with climate change.

1.2 This Report

Our report follows a similar format to that of the executive summary from the statutory guidance document. We have included the outcome of our recent PACT self assessment, this provides additional feedback on our existing management process and principles and is taken into account in our adaptation strategy.

Climate change is just one of the strategic risks embedded in our company conscience. Where possible, we have detailed current adaptation actions, as these are already published in statutory plans. Where we have identified potential consequences, not covered by existing plans, we have made suggestions of what should be implemented.

2 WHO WE ARE AND WHAT WE DO

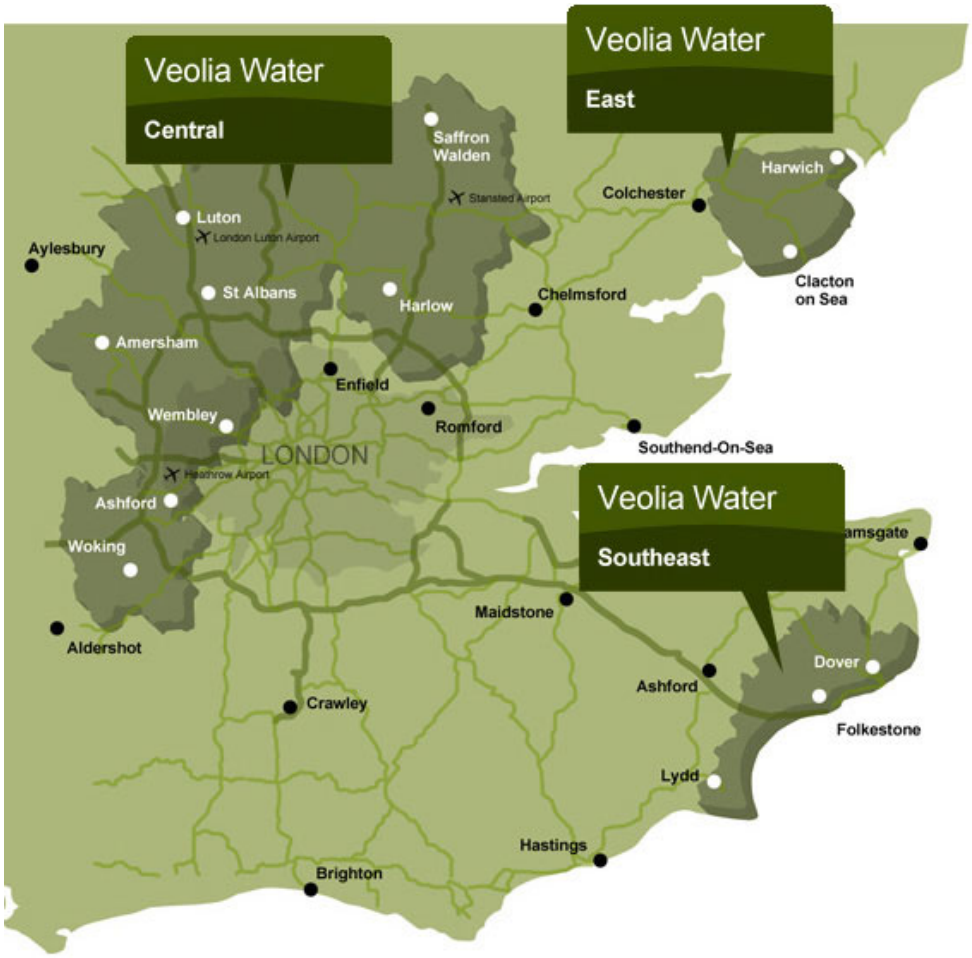
Current Defra climate change scenario predictions indicate that weather in our region will become more extreme in the winter and summer. Average annual precipitation will remain relatively unchanged, but will be more intense in the winter leaving us with drier summers.

Water supply is an area where many of the effects of climate change will be felt first and most acutely. This puts the water industry at the forefront in adapting to a changing climate. Veolia Water Central has experience in planning and adapting to uncertainty in water supply which is reflected in our investment strategies and Business Plans.

2.1 About Veolia Water Central

We are a water only supply company operating in the South East of England as Figure 2.1.a shows. This is a very dry region, with only half the average UK rainfall.

Figure 2.1.a: Veolia Water Central within the Southeast of England



We supply 1.1 million households and a number of commercial businesses and provide public water supplies to a population of 3.2 million in the Home Counties to the North and West of London. Key statistics for Veolia Water Central are shown below

- We supply around 860 million litres of water a day on average
- 40% of our customers pay by water meter

- Daily demand for water in our area per person is 8% above the national average
- 60% of our water is abstracted from groundwater sources (boreholes and wells)
- 40% of our water is abstracted from river sources
- 82% of water put into supply requires complex treatment and therefore associated financial and environmental costs.
- Our water supply network includes over 14,000km of water mains
- We operate 87 water treatment works, 260 boreholes, 130 service reservoirs, 63 water towers and 187 pumping stations
- Our operations release about 0.3 tonnes of carbon dioxide for every million litres of water delivered.

2.2 Veolia Water Central Business Functions

As a water services company, operations are intrinsically linked to the weather. The following section identifies our main business functions which we believe are potentially at risk to the climate change predictions of UKCP09.

2.2.1 Managing Water Resources Sustainably

Sustainable water management is at the heart of our business. We extract water from both ground and surface supplies whilst we also import water from neighbouring companies. Our Water Resources Management Plan shows that there is currently sufficient clean, wholesome water available to us, but we also have to balance the competing pressures of economic growth, pollution risk, environmental protection, and of course; climate change. Our job is to find a way of balancing those pressures whilst ensuring that supplies of water to our customers remain secure and of the highest quality.

We must also do this at a price which the customer is willing to pay for.

2.2.2 Meeting Future Demand for Water

We have a duty to provide water in sufficient quantities to meet the demands of all our customers. We want to do this at a price that is affordable and which takes into account the effects of climate change.

We maintain an extensive array of assets such as reservoirs, treatment works and pumping stations, with a current replacement cost of £4 billion. They generally have a long life, in certain classes beyond 60 years. The continued serviceability of these assets is essential for the constant delivery of a wholesome product in the quantities demanded. The identified risks posed by climate change (such as increased flood propensity) are taken into account in our plans to ensure the reliability of these assets is preserved and with it, our ability to meet demand.

We must also do this at a price which the customer is willing to pay for.

2.2.3 Providing Water Which Meets Drinking Water Inspectorate Standards

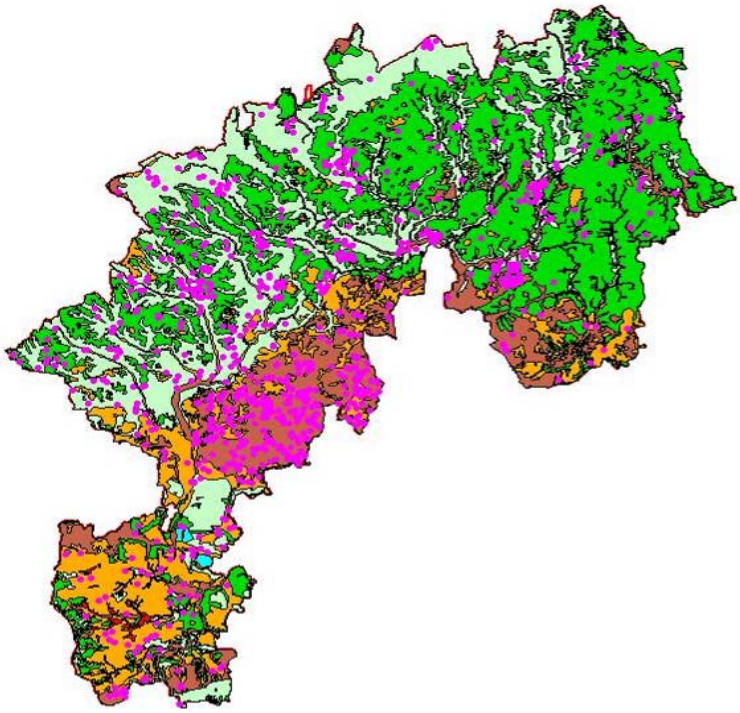
We are committed to providing safe, high quality drinking water for our customers. We do this by operating and maintaining our assets diligently along with sampling and testing the quality of our water. We monitor groundwater and surface water quality continuously, assess risks regularly, and install appropriate treatment where necessary to ensure compliance with drinking water standards.

Providing water of sufficient quality is a regulatory requirement, we need to respond with positive action to retain our customers' faith and confidence in our water. We will build on our previous compliance figure of 99.98% and continue to aim for 100% compliance in all treated water quality. With all our adaptation actions, we must ensure our final product remains of the highest quality. We must also do this at a price which the customer is willing to pay for.

2.2.4 Providing a Reliable Network Infrastructure which Adheres to Regulation

We maintain a network which delivers drinking water to 3.2 million people. Our network of underground pipes extends to over 14,000 kilometres and in our most populated regions they lie in an aggressive London Clay soil environment prone to movement from shrinkage and expansion. These areas are sensitive to adverse weather conditions and our pipe burst rate is much higher here than anywhere else as Figure 2.2.a shows.

Figure 2.2.a: Diagram showing bursts (pink dots) are more prevalent in grounds characterised by London Clay (brown areas).



We react quickly to ensure that supplies are returned to normal following bursts. If the effects of climate change cause burst rates to increase, it is likely that due to the economics of pipe leakage, pipe replacement will become more common than repair.

We must also do this at a price which the customer is willing to pay for.

3 OUR RISK ASSESSMENT APPROACH

Due to the varying nature of our business it is impossible for us to adopt a single methodology for assessing and quantifying all our risks. We employ different methodologies for different types of risk. This section will describe the risk management process for strategic risks which threaten to affect our business objectives.

Climate change is considered a contributory factor towards some of our strategic risks (for example the risk of long term insufficiency of water), rather than a strategic risk in itself. Appendix C lists the risks which are likely symptoms of the UKCP09 projections on a likelihood/severity matrix. For items such as “BURST RESULTING IN LOSS OF SUPPLY DUE TO GROUND MOVEMENT” climate change may be only a contributing factor towards this risk which in turn is only a contributing factor towards our the strategic risk of guaranteeing sufficient water long term.

It is for this reason that VWC is unable to differentiate the effect that climate change may have on our operational performance despite being well prepared for changes in the environment. Our periodic plans describe the effect of climate change on our operations and the proposed actions to facilitate adaption. It is primarily through this process that climate change risks are identified, explored, and monitored. One of the aims of this report is to demonstrate that we consider climate change in our planning and that, through our continual monitoring and periodic review processes, we are well prepared.

For each of our specific identified risks, the methodology used has been described in the relevant sections of this report.

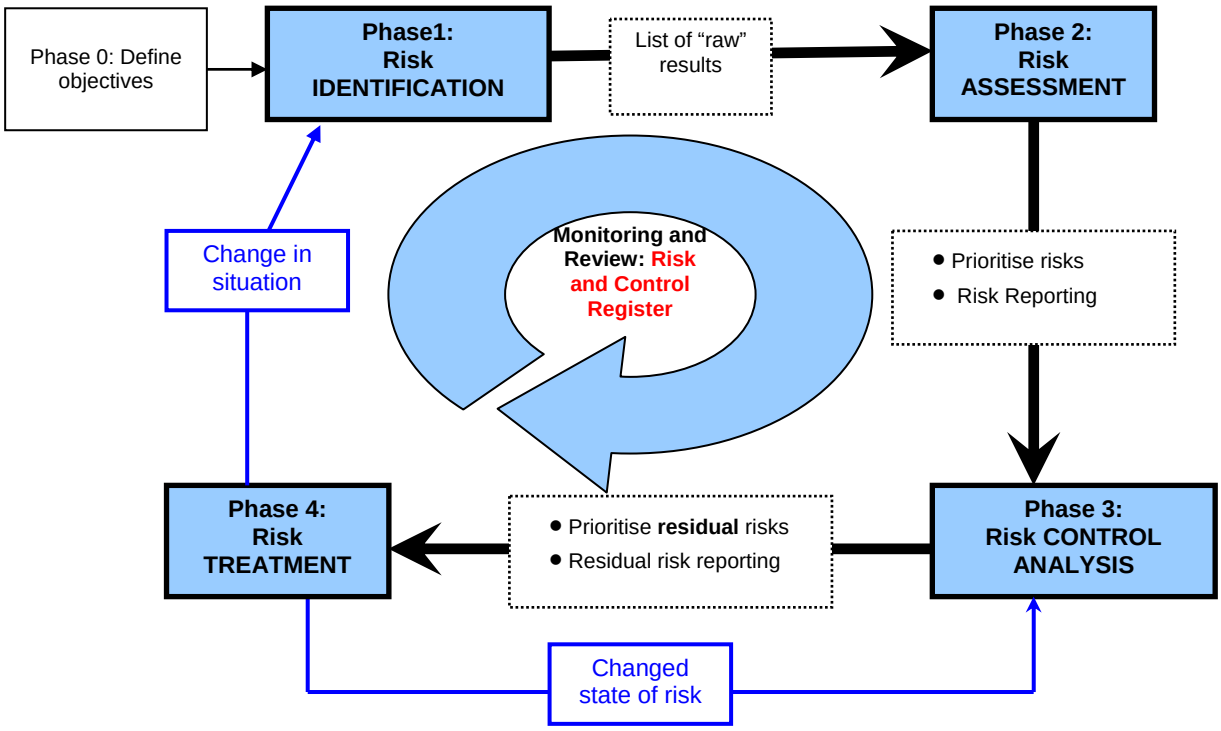
3.1 Strategic Risk Management Process

We believe that risk management should be an active, continuous and developing process which runs throughout our organisational strategy and should methodically address all the risks surrounding our current and future activities.

Risk management at VWC is integrated into the corporate culture of the organisation through an effective policy and program led by senior management. It translates the strategy into tactical and operational objectives, assigning responsibility throughout the organisation and support accountability and reward, thus promoting operational efficiency at all levels.

Our approach is very similar to the UKCIP, Defra and Environment Agency framework *(Climate Adaptation: Risk, Uncertainty and decision-Making - UKCIP Technical Report. May 2003)* in that it is a continuous improvement cycle but as Figure 3.1.a shows; is flexible and appropriate to our organisation and the water industry as a whole.

Figure 3.1.a: Veolia Water risk assessment methodology structure



This section describes the process used when compiling and reviewing our corporate strategic risk register. As mentioned, it is not specific to climate change but enables us to remain prepared and flexible to changing conditions.. The process itself is in four broad phases, *Risk Identification, Risk Assessment, Risk Control Analysis* and *Risk Treatment*.

3.1.1 Phase 1 - Risk Identification

Table 3.1.a: Phase 1 - risk identification as seen on the VWC corporate risk register

Phase 1 - Risk Identification					
Corporate Risk Name	**Risk ID**	**Risk Description**	**Effect**	**Risk Context**	**Risk Owner**

Risk identification is the first step of the process. Risks are identified as comprehensively as possible by one or more of the following techniques: Check List, Questionnaires, Interviews/Experience, Brainstorming Workshop, Assumption Analysis, Expert Facilitation and by the review of reports including corporate goals, audit outputs, incident investigations, changes in legislation or regulation etc. The approach ensures ownership by activity stakeholders and takes into account the experiences they may have had of past comparable projects as well as existing operations.

Internal and external factors affecting the strategic risk are considered as part of the evaluation process. Internal factors are assessed against missions and objectives whilst the PESTEL method is used for external factors:

- **Political**: government direction, social welfare policies, taxation policy.

- **Economic factors**: inflation, unemployment, disposable income, money supply.
- **Socio-cultural factors**: levels of education, population demographics, income distribution, social mobility, lifestyle changes, attitudes to work and leisure.
- **Technological**: new discoveries/development, speed of technology transfer, rates of obsolescence.
- **Environmental**: environmental protection laws, waste disposal, energy consumption, climate change
- **Legal**: competition law, employment law, health and safety, product safety.

Each identified risk is entered into the corporate risk register under the "Risk Identification" heading. Table 3.1.a is an example of the headings included in this section from the VWC risk register. Also included is a short description of the risk and a summary of the potential effect it will have on the business.

At this point in the process the 'risk owner' is identified. The responsibility will sit with an accountable manager whose activities would be affected if the threat materialises.

3.1.2 Phase 2 - Risk Assessment

Table 3.1.b: Phase 2 - risk assessments as seen on the VWC corporate risk register

Phase 2 - Risk Assessment		
Severity	**Likelihood**	**Score**

Once the risks have been identified and defined, they can be assessed and scored in terms of probability of occurrence (likelihood) and potential impact (severity) of that occurrence in order to provide a ranking to prioritise those that are most significant. In doing so, risk response is targeted to achieve the greatest effectiveness in risk reduction based on these two parameters. The assessments are undertaken by those experienced with the risks in question. In Phase 2, risk are assessed with NO controls in place.

The probability for each risk materialising are scored from 1 (low likelihood) to 4 (very high likelihood) and entered into the "Likelihood" column of the risk register. Table 3.1.c outlines this classification.

Table 3.1.c: Risk Assessment probability classification

Descriptor	Likelihood
1- low	Has never occurred / < 10% chance
2- medium	Occasional occurrence / 10% to 50% chance

3 - high	Regular occurrence / 50% to 90% chance
4 - very high	Frequent occurrence / > 90% chance

Once a score for likelihood has been determined, a similar process is used to determine the severity of each risk. The impact/severity should be scored from 1(low severity) to 4 (very serious). The severity for each risk identified is scored against sdix impact categories to the company:

- **People** : number and competence of staff, turn over, skills, training needs, motivation and commitment, incentive packages available, security, employment contracts, workers safety etc
- **Pounds** : financial and economic impacts
- **Product** : impacts on the quality and quantity of water
- **Places**: offices, amenities, production sites, security of supply infrastructure, land management, biodiversity, environmental impacts (energy, waste)
- **Regulation** : compliance and corporate governance
- **Reputation**: customer satisfaction, media coverage, feedback from stakeholders, regulators and customers.

Guidance for scoring severity is provided in Table 3.1.d and the evidence and expert opinion are described for the risks mentioned in this report

Table 3.1.d: Risk Assessment severity classification

Severity- examples - 1 - low					
People	**Pounds**	**Places**	**Product**	**Regulation**	**Reputation**
No impact on employee / public H&S. Staff turnover less than 10%. Employee satisfaction from staff survey >75%.	no financial impact – positive financial impact	No adverse environmental impact/positive environmental benefit. No security incidents or trespass & minor vandalism with no effect on operations, employees and the public.	**Quantity** No impact on the water quantity **Quality** No impact on the water quality	No system failure/positive improvement. No legal impact. Positive feedback from regulator.	No adverse media attention/coverage- positive feedback from stakeholders- unsolicited promotion of brand. No customer complaints. Positive feedback from customer survey.

Severity- examples - 2 - quite serious					
People	**Pounds**	**Places**	**Product**	**Regulation**	**Reputation**
Non reportable injury requiring <3days absence or reportable accident under RIDDOR requiring >3days absence. Slight injury to member of the public. Recorded near miss. From public complain to improvement notice. Staff turnover less than 10%. Employee satisfaction from staff survey 50-75%.	<£5m	Moderate damage to property. Uncontrolled release or spill – impact on local area/public complaint or enforcement notice. Criminal activity having impact on the Company but does not effect customers or the public.	**Quantity** Interruption to supply of water to up to the equivalent of 20,000 property hours **Quality** Deterioration of water quality likely to lead to classification as an incident or discolouration or aeration (i.e. aesthetic impact only)	Minor breaches and requests for additional information and/or civil claim for damages. Down grading of DG indicators	Local media coverage 24hrs-14days. Indirect criticism by stakeholders. Short term damage to brand Failure to meet customer's expectation. Disruption to customers or their activities>3days. Unable to communicate with customers for 2-8hrs.
Severity- examples - 3 - serious					
Serious reportable injury requiring long term absence. Serious injury to member of the public. Prohibition notice or prosecution Staff turnover >10%. Employee satisfaction from staff survey <50%. Loss of key skills / critical roles	£5-25m	Serious damage to property. Very serious releases of spill – localised evacuation / fish kill. Significant pollution Specific criminal or terrorist action against the Company which impacts on the public or customers	**Quantity** Interruption to supply of water to up to the equivalent of 100,000 property hours **Quality** Deterioration of water quality likely to lead to enforcement action and potential prosecution; or do not DRINK notice.	Failure of systems leading to significant and resistant breaches and prosecution. Downgrading in Ofwat performance league resulting in regulatory penalty.	National media coverage 24/48hrs –comments by stakeholders-medium to long recoverable term damage to brand. Loss of several principal customers. Repeated extensive disruption to customers. Unable to communicate with customers >1 day.
Severity- examples - 4 - very serious					
Loss of life Corporate manslaughter. Prosecution. Staff turn over >20%. Employee satisfaction from staff survey < 50%. Loss of key skills / critical roles	>£25m Massive fine against the Company	Permanent damage to area. Severe property damage. Facilities no usable. Long term or irrecoverable environmental damage. Multiple terrorist attacks.	**Quantity** Interruption to supply of water to more than the equivalent of 100,000 property hours **Quality** Deterioration in water quality likely to lead to loss of licence; or do not USE notice	Withdrawal of license. Complete failure or non-existence of control system. All non-conformances not closed out. Imprisonment of Directors	Sustained national / international media coverage, openly critical feedback from shareholders, regulators and customers; irrecoverable damage to brand and company. Loss of all principal customers to competition. Unable to communicate with customers >2 days

These categories are individually scored from 1 to 4. The severity is calculated by adding each category's score and dividing the total by the number of categories for (7).

Categories scored at level 1 are not considered in this calculations as the risk wouldn't have any impact on them.

An example of this is shown in Table 3.1.e below.

Table 3.1.e: Calculation method for likelihood/severity matrix for risk example

Risk description	Likelihood (L)	Severity (S)							Risk score (LxS)
		People	Pounds	Places	Product		Regulation	Reputation	Total	
					QT	QL				
Failure on the network resulting in widespread loss of supply	**1**	**1**	**2**	**1**	**3**	**3**	**3**	**3**	**(2+3+3+3+3) / 5 = 3**	**3**

The result is then compared against our risk rating matrix, as shown in Table 3.1.f and colour coded as Red, Amber or Green depending on the final severity/likelihood score. Table 3.1.g explains the meaning of each score in more detail.

Table 3.1.f: Risk Assessment - risk rating matrix

SEVERITY	**4** = Very Serious	**4**	**8**	**12**	**16**
	3 = Serious	**3**	**6**	**9**	**12**
	2=Quite serious	**2**	**4**	**6**	**8**
	1 =Low	**1**	**2**	**3**	**4**
		1= low	**2**= medium	**3**= high	**4**=very high
		LIKELIHOOD			

Table 3.1.g: Risk Assessment - total risk score guide

Descriptor	Guide
9 – 16 High risk	Should trigger a review of existing controls, is likely to require the implementation of additional controls and the problem should be escalated to the RMC (Risk Management Committee) or relevant committee for consultation. Risk reduction measures should be implemented within a defined time

	period. Risks with this score should be reviewed monthly.
6 – 8 Significant risk	Should trigger a review of existing controls for new risks, and may require the implementation of additional controls for existing risks and the problem may be escalated to the RMC (Risk Management Committee) or relevant committee for consultation. Risk reduction measures should be implemented within a defined time period. Risks with this score should be reviewed monthly.
4 Moderate	Should trigger a review of existing controls for new risks, and may require the implementation of additional controls for existing risks. Risk reduction measures might need to be implemented within a defined time period. Risks with this score should be reviewed quarterly to twice a year**.**
1 – 3 Low risk	Should require no mitigation action. However, risk owners should review controls for low risk areas to ensure they are effective and not disproportionate. The risk score should be reviewed annually.

The results of the risk assessment activities are documented in the Risk Register under the appropriate heading seen in Table 3.1.b.

3.1.3 Phase 3 - Risk Control Analysis

Table 3.1.h: Phase 3 - risk control analysis as seen on the VWC corporate risk register

Phase 3 - Risk Control Analysis				
Current Control	**Severity**	**Likelihood**	**Residual Score**	**Risk Review Date**

The purpose of this phase is to identify controls that are already in place that can help mitigate and manage the risks that have been identified and scored in Phase 1(risk identification) and Phase 2 (risk assessment). This is the responsibility of the risk owners and line managers who are responsible for the activity.

A similar process used to identify risks is used to identify potential controls. This stage aims to assess if the current control is appropriate.

There are many different types of controls. They tend to fall into four categories.

- **Directive controls** – defined instructions and include things such as policies, procedures, signs, posters etc.
- **Preventative controls** –ensure that appropriate access is maintained, for example: locks, fences, passwords, training, physical barriers, software barriers .
- **Detective controls** – ensures that there is appropriate accessibility to information, such as: testing, inspections and sampling records.
- **Corrective controls** –ensure that identified issues can be remedied. This may be applied in situations where it may be impossible to predict when and where an incident may happen and include continuity planning ensuring gaps can be filled, technical solutions can be applied and training can be provided.

Once existing controls currently in place to mitigate risks have been identified, the likelihood and the severity of the risk will be re-assessed in the same manner as detailed in Phase 2, in order to calculate a the residual risk. If no controls exist the residual risk score will stay the same as the initial risk score calculated in Phase 2.

When controls are identified and residual risk scored, this information is added to the Risk and Control Register under the appropriate heading seen in Table 3.1.h.

An independent internal audit is also carried out at this stage. This internal audit will contribute to the risk management process by providing assurance on three areas:

- Risk management processes, both in terms of design and effectiveness
- Management of those risks classified as “key”, including the effectiveness of the controls and other responses to them
- Reliable and appropriate assessment and reporting of risks and control status.

The core role of the internal audit in relation to risk management should be to provide assurance to senior management and to the Board on the effectiveness of risk management.

3.1.4 Phase 4 - Risk Treatment

Table 3.1.i: Phase 4 - risk treatment as seen on the VWC corporate risk register

Phase 4 - Risk Treatment								
Strategy Tolerate, Terminate, Transfer, Treat	Action Plans - to upgrade the controls or monitors	Cost of mitigation (to implement the action plan)	Links to other risks	Target Score	Specific Actions	Action Owner(s)	Baseline Due Date	Expected Completion

Effective risk management requires a reporting and review structure to ensure that risks are effectively identified and assessed and that appropriate controls and responses are in place.

Existing controls identified in Phase 3 will be monitored by the risk owner and it is their responsibility to decide if the residual risk score is acceptable. If the residual risk is to high or if there are no current controls in place for the risk, new controls have to be implemented as action plans to mitigate the risk: this is what happens in the risk treatment phase.

For each of these instances we evaluate the potential next steps, known as “The 4 T’s”. These are:

- **Tolerate**

  We reluctantly choose to accept the inherent risk: the cost of control outweighs any potential benefits. Tolerated risks are common and steps are always taken to ensure that the risk is minimised. As and when a suitable control action is identified, it may be implemented.

- **Terminate**

  The project or operation is cancelled or ceased. This occurs if the threat of the risk is too great and no suitable control action can be found.

- **Transfer**

  The responsibility of the project or operation is shared with another organisation,for example, external contractors are hired. For specialist projects, it is often the preferred route in order to ensure that the project is undertaken by staff appropriately equipped for the associated risks. This option however is only used if all internal possibilities have been explored.

- **Treat**

  The risk is reviewed and an appropriate control action developed which is fit for purpose. This would involve controlling and managing both the likelihood and severity of the risk on the project or operation.

If the residual risk score is not acceptable the risk owner needs to decide upon a suitable target score and create actions to help reach that target score. The actions will attempt to help the risk reach the target score through either mitigation, avoidance (or both) and to help monitoring the process, determine a date when this new action is to be completed by and the risk management representative who will be responsible for it.

The monitoring process should provide assurance that there are appropriate controls in place for the organisation’s activities and that the procedures are understood and followed.

Any monitoring process and review process should also determine whether:

- the measures adopted resulted in what was originally intended
- the procedures adopted and information gathered for undertaking the assessment were appropriate
- improved knowledge would have helped to reach better decisions and identify what lessons could be learned for future assessments and management of risks

At the end of this phase, when the action plan has been implemented, the risk is reassessed, with the outcome from the action forming the new current control in the register. The risk, with the new control, is then rescored and the risk owner compares this score with the action logs original target score. The risk owner then assesses whether the new residual risks score is now acceptable. If not, a new target score is selected and a new action plan is drafted. This form of review continues until either the situation changes and then the process restarts at Phase 1, or all the possible controls have been applied and the risk is at its lowest score.

If risk materialises despite mitigation (for example: flood defences fail) contingency plans are put in place in order to react to the situation. Contingency plans are also a form of corrective control and can be used when the cost of removing the risk or applying other controls is excessive.

4 RISKS TO VWC BUSINESS FUNCTIONS FROM CLIMATE CHANGE

Climate change may manifest itself in ways which reduce our ability to meet demand such as a reducing supply base, infrastructure issues, and simply being unable to cope with rises in demand. As a business we aim to meet our customers demand with clean and safe drinking water at an acceptable price. The following section outlines the risks to our organisation's business functions and how climate change will cause them to be an issue.

Appendix C transfers the risks mentioned in this chapter to a likelihood/severity matrix. Although we do not have specific climate change risks on our corporate register, the following effects of changing weather on our operations have been detailed and assigned a likelihood and severity scoring for easy comparison across the industry. The likelihood and severity weighting for each risk is taken from the defined corporate risk of which the issues mentioned here are a part of. i.e. this section describes how climate change will affect burst rates, but our corporate risk for burst resulting in loss of supply is not climate change specific but includes it as one of many contributing factors.

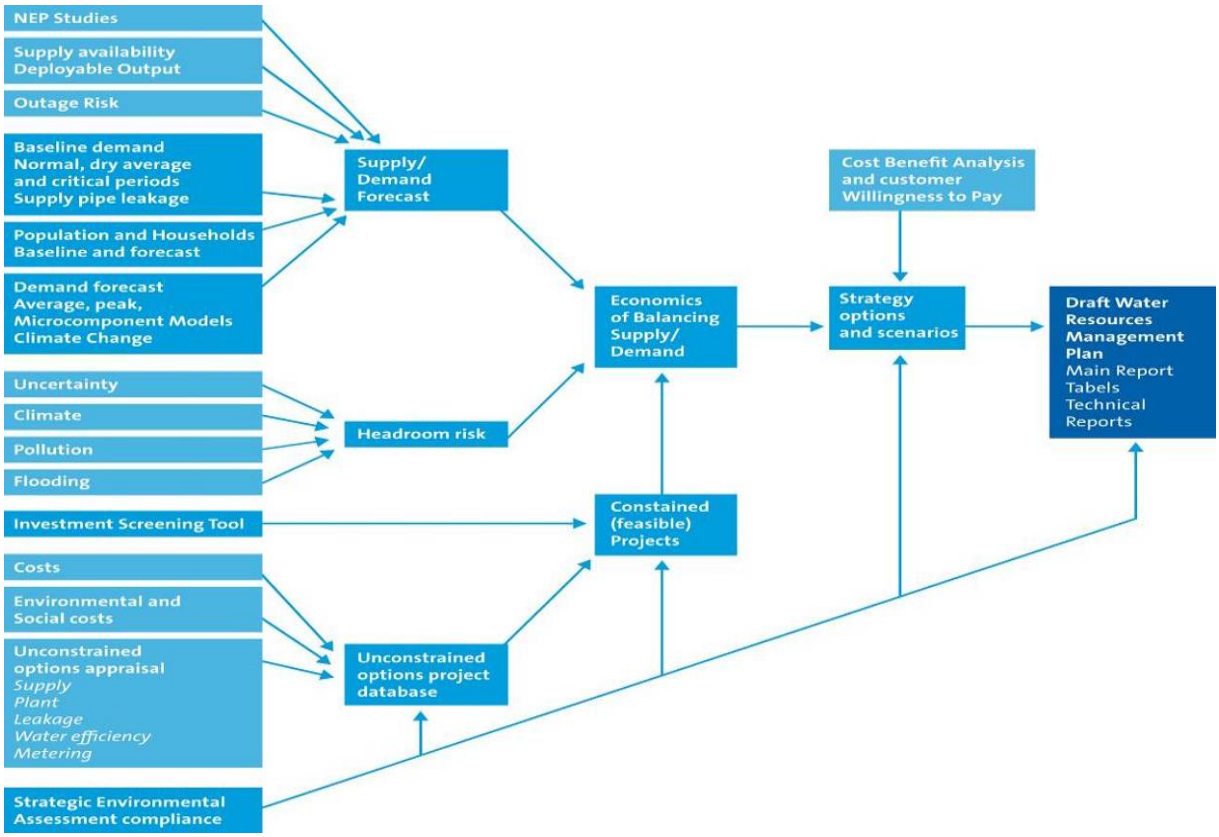
4.1 Water Scarcity

Our organisation is relatively resilient to drought with compulsory restriction orders being rare. However a series of dry winters may deplete our groundwater supplies and cause problems in meeting a consistently high public demand. UKCIP CP09 projections predict an increase in the frequency of droughts and so proper planning in this subject is taken very seriously. For this reason it is important to have accurate predictions regarding if, and how, water scarcity will affect us.

4.1.1 Summary of Methodology Used

Our ability to meet future demand for water is monitored in our *Water Resources Management Plan* which has a planning horizon of 25 years; but we have also looked beyond that in order to assess the impacts of climate change, (to 2050 and 2080). We have used the CP09 findings for weather scenarios throughout the 21st century and have considered the worst case scenarios during our approach.

Figure 4.1.a: Schematic representation of WRMP Studies



To build our Plan a number of studies have been carried out including forecasts of the amount of water available to meet the demand of our customers. These are combined to assess any actions needed to maintain security of supply. The study elements used are shown in Figure 4.1.a.

Figure 4.1.a demonstrates the scope and quantity of studies that go into our methodology for assessing supply and demand risks. Our approach is informed through years of data and experience and we consider it to be appropriate for use. Findings from the studies are then evaluated and individually weighted by experienced engineers to generate a well informed and balanced plan. Copies of the technical reports are included on our website[1].

4.1.2 Increased Demand

Added pressure on present and future water resources is imposed by expanding urban environments. We recognise that in our region, further urbanisation is needed for economic growth which generates increases in population and houses. Our plans will need to be secure, but possess a degree of flexibility in the longer term to ensure we develop new resources where necessary and in conjunction with demand management, moderate the demand for water and reduce leakage.

We have identified that demand is likely to increase as a direct result of climate change. UKCP09 predictions for our region predict a net increase in temperature across the year. As historical data shows, temperature increases have a direct relation to demand due to changes in usage.

[1] https://central.veoliawater.co.uk/

Our studies predict that demand across our region in 25 years will be higher than it is today. We expect around 200,000 new houses will be built in the next 20 years, mostly in the east and north of our operating area. We expect overall demand to increase by 11%. Experian's policy based household projection goes as far as to expect a 35% rise in households across the region by 2040, a prediction supported by the Environment Agency. If current consumption rates continue, demand will exceed supply well before 2040.

The above information, whilst not direct results of climate change, may be contributing factors towards our inability to meet demand. Climate change, potentially leading to longer and hotter summer periods, will also drive more frequent and higher peak seasonal demands. This is confirmed by the key findings of UKCP09 projections which have indicated that warming will be likely and more intensified in the summer months. Increases in temperature are directly linked with increases in demand with all water companies experiencing huge demand peaks in the summer months.

The effects of climate change on demand have been modelled in accordance with the final CC:DEW Climate Change and Demand for Water report prepared by the Stockholm Environment Institute in 2002. Increase in demand is a difficult risk to quantify and this is reflected in the headroom of our predictions as shown in Figure 4.1.b and Figure 4.1.c. Our headroom considers the uncertainty in our calculations as well as providing a safety margin allowing for flexibility within our operations. We know that increases in temperature cause increases in demand but when combined with our continued water efficiency operations, we have found it difficult to project into the future.

If left untouched, demand will outstrip supply and we would need to seek out additional water sources. Investing in new water sources is financially, as well as environmentally costly so as a business we aim to manage our water resources sustainably. By introducing water efficiency measures across the network we can slow the rate at which demand load is increasing in our region and ensure that climate change impacts do not cause us to fail to meet future water demands.

4.1.3 Reduced Supply

In preparing our plan for the next 25 years we considered factors likely to influence the amount of water available, such as climate change and pollution. Based on our studies for our Water Resources Management Plan we have allowed for a sustainable reduction in water availability of around 2% by 2030 as a result of climate change. Other planning documents, for example, the Secretary of State's own Future Water, also suggest that we can expect such reductions over the period.

Our work for our Water Resources Management Plan shows that if expected reductions in water use, as a result of our proposed water efficiency operations continue, we will not need to develop any new water resources until after 2035. Figure 4.1.b and Figure 4.1.c demonstrate how having a proactive 'water neutral' strategy means we will be able to defer the need for investment in new resources until that time. But it takes a long time to plan, get consent for, and build major new sources of water so we need to continue to explore options for resource development in order to retain flexibility in our planning.

Figure 4.1.b: Water supply forecasts with no demand savings from metering - critical period

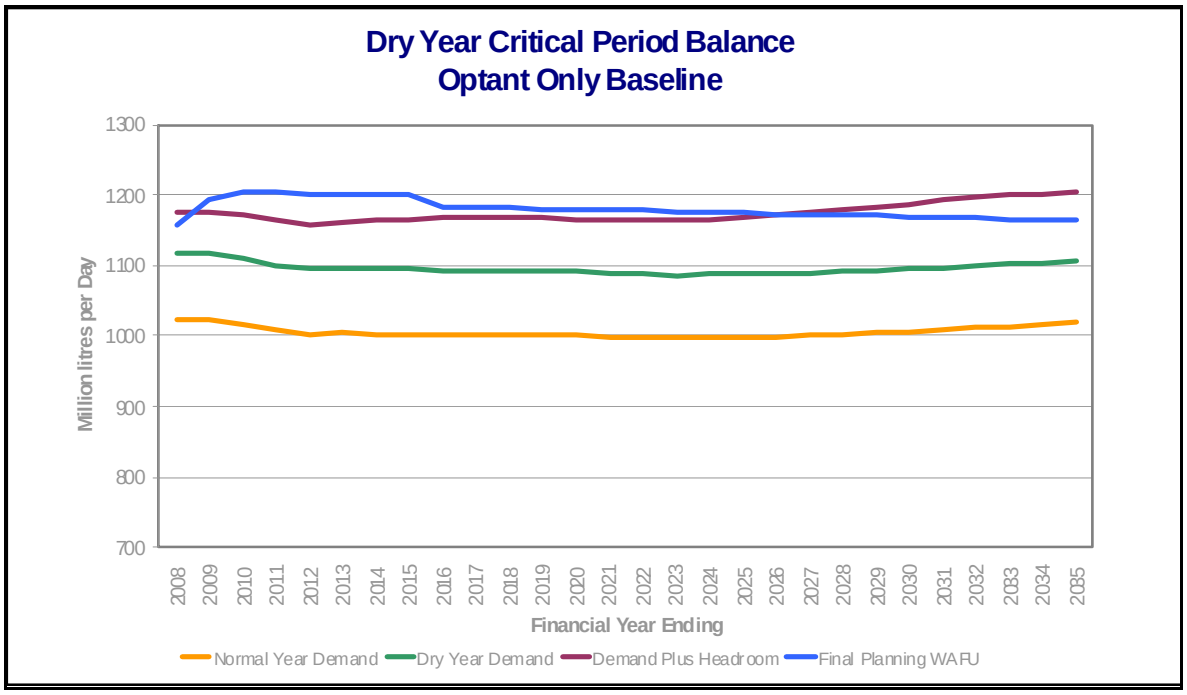
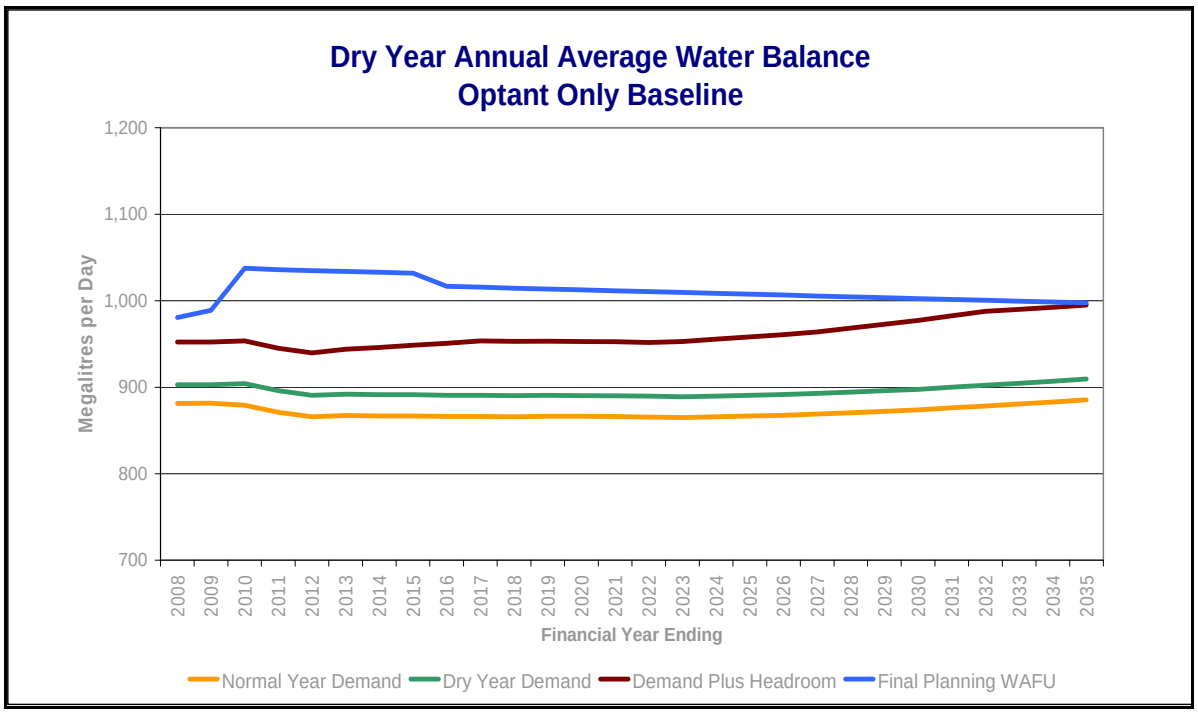


Figure 4.1.c: Water supply forecasts with no demand savings from metering - average period



Changing rainfall patterns caused by climate change may reduce the recharge of our underground sources and as already mentioned, increase demand in the summer months at the same time. UKCP09 findings showed that annual precipitation will remain relatively unchanged but will be more intensified during the winter meaning there will be drier

summers. This potentially could cause problems with our surface water sources as prolonged drier periods reduce river water levels.

A major study undertaken for our Water Resources Management Plan to assess the various consequences of climate change on our ground water resources predicted that ground water levels will fall despite increased winter rainfall. Changes in climate resulting in a longer series of dry winters will increase our vulnerability to drought. We will build an additional provision into our Water Resource Management Plans to allow for these risks.

Figure 4.1.b Figure 4.1.c Illustrate our current demand projections against the current supply projections until 2035. It is clear that if our predictions are correct, demand will outstrip supply by this time, and new water sources would need to be sought. As a business, one of our main priorities is ensuring we meet future demand for water. It is clear that the effects of climate change put this operation at risk which is why we continually work to increasing our resilience in this area.

4.1.3.1 Groundwater

We have over 260 operational boreholes at 110 locations distributed across our area. As boreholes contribute around 60% of our supply, it is important to have an accurate and robust approach to determining the consequences of climate change.

4.1.3.1.1 Summary of Methodology Used

Our current source yield assessment methodology used to calculate our groundwater levels is based on the earlier approaches outlined in the following reports:

- *A Methodology for the determination of Outputs of Groundwater Sources (UKWIR): Beeson, van Wonderen and Mistear (1995).*
- *NRA R&D Note "Surface Water Yield Assessment" (1995).*

Attempts have been made to expand and update the 1995 methodology by UKWIR and the Environment Agency in order to overcome limitations and reflect new regulatory requirements. This work is detailed in the following documents:

- *A unified Methodology for the Determination of Deployable Output from Water Sources, UKWIR/Environment Agency (2000).*
- *Critical Period Groundwater Yield, UKWIR/Environment Agency (2001).*

The UKWIR/Environment Agency proposed methodology revisions are both data intensive but are likely to be adopted as best practice in the future. We expect to continue working on this approach and feel that these methods will allow us to determine groundwater deployable output for given weather scenarios. This will enable us to plan more accurately and embed flexibility in many of our solutions.

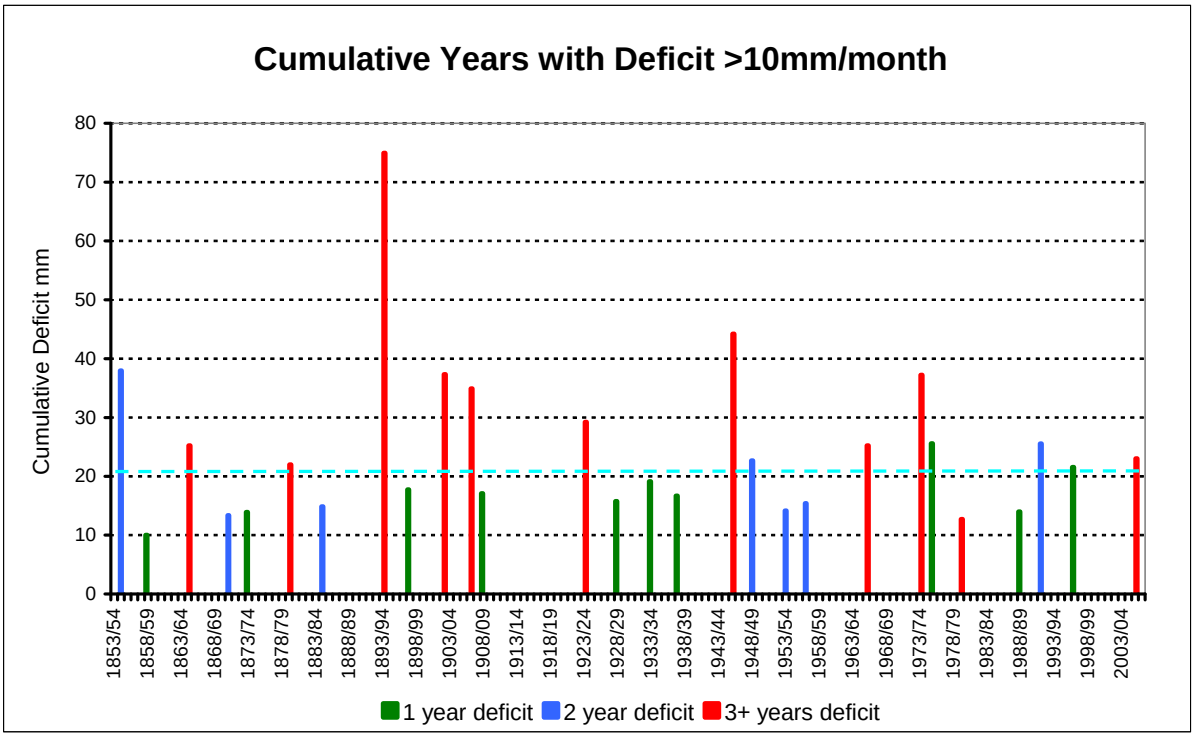
Findings from our studies contribute to our overall understanding of the effects of climate change and also give an indication of how this could affect our business functions. This information is used to formulate our risk register and enables us to identify appropriate actions.

4.1.3.1.2 Potential Impacts of Climate Change

We recognise that climate change may alter the quantity and patterns of precipitation in our region. We consider historical, as well as future predicted rain fall statistics in our water resource planning. A long term rainfall data set has been obtained for Oxford, from 1853. The Oxford rainfall sequence provides a means to consider the frequency of low rainfall events and in turn an estimation of the frequency of low supply events. Whilst not in our region, Oxford experiences very similar weather patterns, allowing us to benefit from the accurate long term data collected.

For our Water Resources Management Plan, the Oxford rainfall data set was subjected to a number of statistical analyses to derive return periods of particular rainfall events. One of the most illustrative outputs from this is shown in Figure 4.1.d. Here, the cumulative deficit of average monthly rainfall from one, two or more successive winters is shown as mm deficit from the long term average. The frequency of such deficits is high, with 28 occurrences in the 152 years of record, i.e. 1 in 5. However, not all of these deficits have caused issues with low groundwater levels.

Figure 4.1.d: Distribution of Winter Low Rainfall Events 1853-2005



Analysis shows that only when the deficits exceed 20mm are groundwater levels seen to decline to low levels and the historic record shows water restrictions were required. 15 occurrences of below 20mm deficit are indicated below during a 152 year period, giving a return period of just over 1 in 10. This supports the current level of service and correlates with the frequency of compulsory usage restrictions for our region.

The frequency of these low rainfall events in the past is not necessarily a guide to how they will occur in the future, particularly when climate change is considered. The UKCP09 projections do not show a long term historic decline in overall rainfall patterns, but they do predict more variability. Increased variability could result in more drought condition periods and more flood condition periods.

We work to ensure we can guarantee our supply implementing adaptive action to ensure that when we do experience drought conditions more regularly, we are able to continue operating until the aquifer is able to recharge.

Extreme events such as these are managed by following our published *Drought Management Plan.* This explains our approach and guides the progressive implementation of measures to support our supply/demand balance.

Independent consultants; Jacobs, predict that overall there will be modest changes in groundwater levels throughout the 20th century in our region due to climate change. There will be a reduction in ground water levels of between 3-4 m across the region. We forecast a decrease in Deployable Output due to Climate Change of 27.28Ml/d at average and 29.53Ml/d at peak conditions for the median case. This is a reduction of 2.5 % and 1.9 % respectively of our overall abstractions as Figure 4.1.e shows.

Figure 4.1.e: Supply Forecast including Climate Change

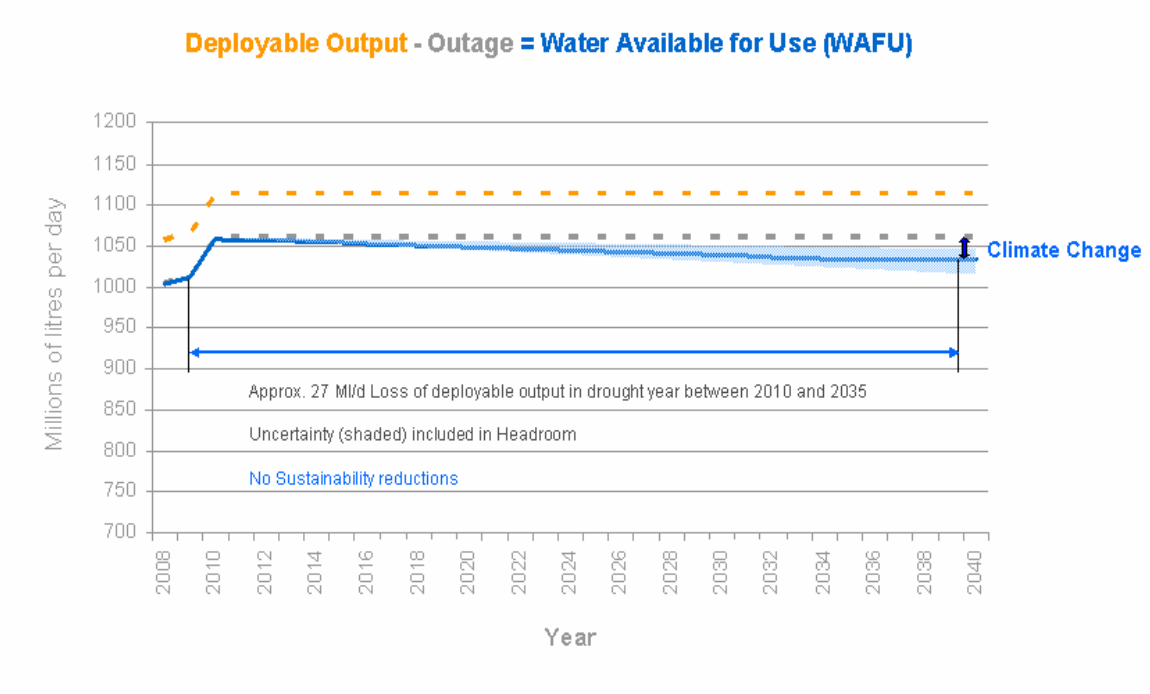


Table 4.1.a: Effect of climate change on ground water resource base assuming no loss of time limited licence

Deployable Output (Ml/d)	2009-10	2011-12	2016-17	2021-22	2026-27	2031-32
Dry Year Annual Average	1113.5	1111.5	1106.4	1101.4	1096.3	1091.3
Dry Year Critical Period	1272.7	1270.6	1265.4	1260.3	1255.1	1249.9
Dry Year Annual Average Change from 2006-07	-	-2.0	-7.0	-12.1	-17.2	-22.2
Dry Year Critical Period Change from 2006-07	-	-2.1	-7.3	-12.5	-17.7	-22.8

It is apparent from the data in Table 4.1.a, as calculated from our Water Resources Management Plan, that deployable output will fall across the region. Although the reduction is currently assessed as relatively minor, we will continue to monitor this situation to ensure

that projections are accurate and that adaptation actions maintain a positive supply/demand balance.

Although over our planning horizon, ground water levels will only fall a small amount due to climate change, a decreasing supply is unsustainable and without our proposed adaptation programme to reduce abstraction, will continue to fall.

If climate projections for variable precipitation are correct, we may also experience a greater frequency of drought conditions by the end of our planning horizon. It is important that to reduce the chance of increasing compulsory restriction bans from 1 in 10, we must consider adapting our strategy.

Our current supply/demand strategy is sufficient to maintain a surplus of supply over demand, but our evidence shows that our ground water deployable output is shrinking whilst demand is increasing creating an unsustainable business model in the longer term. Our adaptation actions detailed later will correct this imbalance, their effectiveness will be continually monitored and periodically reported on in our Plans.

4.1.3.2 Surface Water

The majority of surface water used by the company for potable supply is abstracted from the River Thames and treated at four river water treatment works. Maintaining minimum flows in the River Thames is the responsibility of Thames Water. Our sources have permanent abstraction licences with no flow constraints under drought conditions and therefore when combined are capable of providing sufficient quantities of raw water following prolonged dry spells, such as the dry period encountered during the long hot summer of 1995. Such historical data is highlighted in our Water Resources Management Plan

4.1.3.2.1 Summary of Methodology Used

The methodology (*UK Water Industry Research and the Environment Agency (2000), A Unified Methodology for the Determination of Deployable Output from Water Sources, Report Ref. No. 00/WR/18/2*) does not fully cover river licences, and thus we have developed a methodology and have sought independent confirmation that this complies with the Unified Methodology principals. The deployable output methodology for each site is described in detail in the "*TVW Guidance Note for Deployable Output from River Sources: Issue 1.0"*

This new methodology has been applied to our surface water sources and separate evaluations written for each one. The methodology investigates each of the treatment processes and identifies rate determining steps for each one, identifies process losses and derives both a theoretical flow and an actual flow, based on historic site operation.

4.1.3.2.2 Potential Impacts of Climate Change

The result of this re-assessment is a net decrease in deployable output of the surface sites. This is shown in Table 4.1.b below:

Table 4.1.b: Surface Water Sources

Source works	Difference Ave. Ml/d	Difference Peak Ml/d	Notes
EGHS	24.17	-0.44	Average increase allows group to achieve licence, minus process losses
CHERS	-13.75	-12.96	Refinement of process constraints, based on operational experience
WALS	-7.59	-5.48	Refinement of process constraints, based on operational experience
Group	**2.83**	**-18.88**	Increase in average, decrease at peak. Individual average site DO's constrained by group Licence.
HWFS	1.00	10.00	Increase in peak due to reassessment and current output capability
Total	**3.83**	**-8.88**	**Total = "Group" plus "HFWS"**

The deployable output of the surface water treatment works is constrained marginally by licence volumes at average conditions and by treatment capacity during the critical period. Thus, unless current licence and operating agreement are changed, we are not currently affected by climate change on river flows.

We therefore feel that our current approach to managing surface water is appropriate and that the effects of climate change pose no significant risk to the availability of raw water resources throughout our planning horizon.

4.2 Flood Risk

As mentioned, UKCP09 climate projections point towards a more variable climate with not only an increased probability of drought conditions, but with more intense rainfall patterns also. Projections of increased rainfall are likely to result in higher intensity rainfall events, and longer wet periods. This could give rise to increased flooding, which could affect the way we manage our assets on or near the floodplain. Projections also suggest there could be more surface flooding from rainfall (pluvial flooding) with a corresponding effect on our assets within many urban areas that are not in the fluvial floodplain.

For this reason, we have devoted a significant amount of time and resources to assessing this consequence and preparing our flood defences in line with recommendations made in a number of external reports. The studies showed that like water scarcity, floods have the potential to reduce our ability to meet demand in a number of ways such as contamination of supply, damage/destruction of assets, and restricting access to company sites.

Independent consultants Jacobs found that whilst we have had no flood interruptions caused by flooding, it would be advisable to proceed with our flood protection programme to guarantee resilience. Without our actions, floods, which are a likely symptom of the CP09 climate projections, could very easily overwhelm the network by damaging physical assets such as treatment works, or by eliminating our access to them all together.

4.2.1 Summary of Methodology Used

We are a water company, and as such a lot of our assets are near water and therefore susceptible to flooding and we have begun investing over the next five years to bring about a step change in resilience to both current and future climate conditions.

We started our investigations in September 2007 and engaged Jacobs, a consultant specialising in river flooding investigations. Their report consisted of desk top and on-site surveys which took place on a site by site basis in late 2007. This work helped in identifying solutions to protect against flooding where there was a recognised impact under climate change scenarios. The *Pitt Review* and other studies from our Water Resources Management Plan, as shown in Figure 4.1.a, have been assessed and where appropriate their recommendations adopted in our planning. We contributed to the consultation to develop Ofwat's analytical framework and Water UK's *Climate Change Adaptation Guidance*.

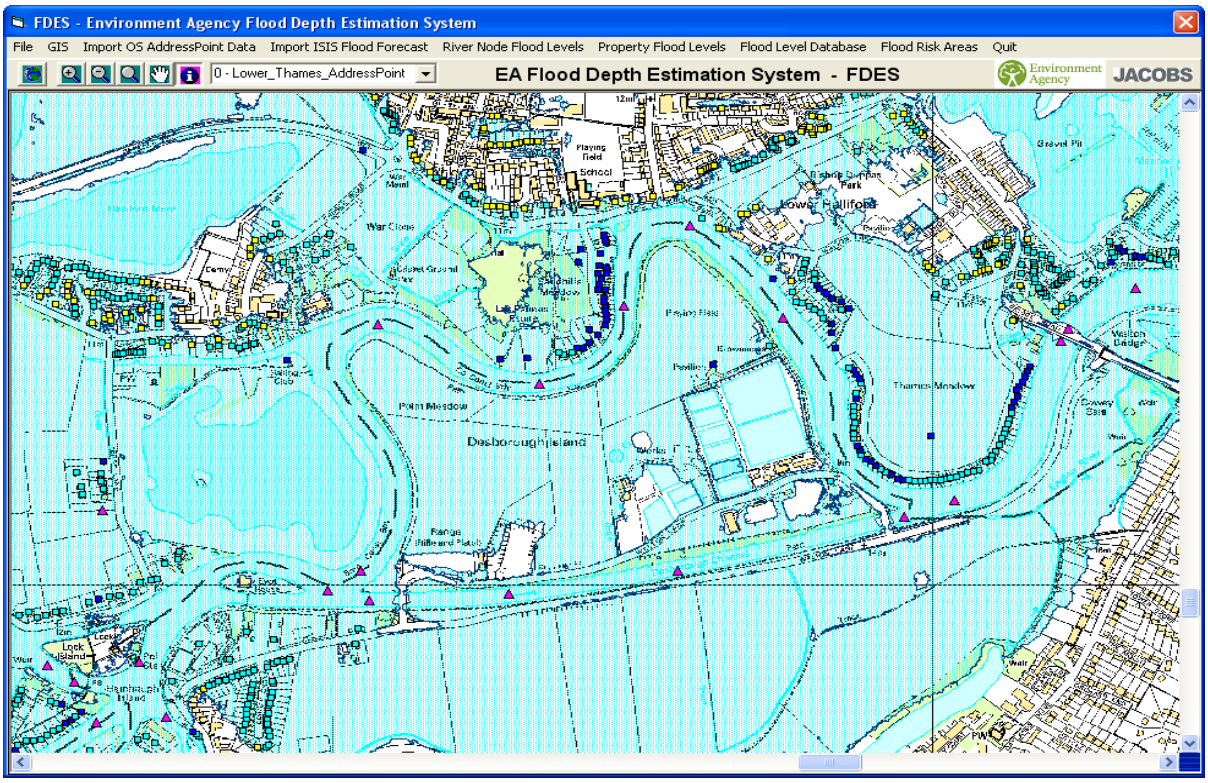
This study predicted an increase in the probability and severity of flooding incidents caused by higher rainfalls, increased uncertainties and increased variability. The *Pitt Review* and many other reports highlight the impacts to local, regional and national infrastructures and recommend actions. As a result, Defra required water companies to assess flooding and include mitigation measures in their PR09 submissions.

Where existing vulnerability to floods have been identified, designs have evolved to protect plant and processes. Many sites, therefore, have some protected assets or have been built above 'flood levels'. Our emergency plan provides a generic approach to incidents and considers flooding as another event that would cause major disruption but not as a specific event that demands particular management. This proved to be an effective approach in response to the July 2007 event. However, as flood events become more prevalent, we may find that a reactionary approach will become financially unsustainable and that adapting our physical assets now is a better option.

In recognition of a different future, Jacobs were commissioned to identify possible adaptation options. Our studies concluded that current flood resilience levels of 1 in 100 year flow were insufficient and did not consider the impact of climate change and the increased likelihood of flood. 1 in 100 year flow events refer to the water level expected once every 100 years. For many of our sites, a current flood resilience level of 1 in 20 years is not uncommon. For this reason, the flood level 1 in 100 year + 20% was introduced across our region as the desired standard. This considers an additional 20% rise in water level for the 1 in 100 year event and accommodates for the impact of climate change.

Initially a desktop analysis was completed to assess which of our assets could be impacted by flooding based on the EA flood risk outline maps of which Figure 4.2.a is an example. We also consulted our database and used past experience of flooding to identify the sites requiring action. The Defra groundwater emergency mapping was also used to assess the possibility of groundwater flooding to our assets. This led to a list of 109 sites that could potentially be affected by flooding brought about by climate change.

Figure 4.2.a: EA Flood map of Walton water treatment works



4.2.2 Potential Impacts of Climate Change

To recognise the increased flood level likely due to climate change, we have introduced new flood plates (see Figure 4.2.b) which are fixed to our assets at the levels where we are likely to see the corresponding flood level. These helped to identify assets and equipment below the projected flood water level and therefore enabled us to focus our adaptation programme.

Figure 4.2.b: Flood level plates

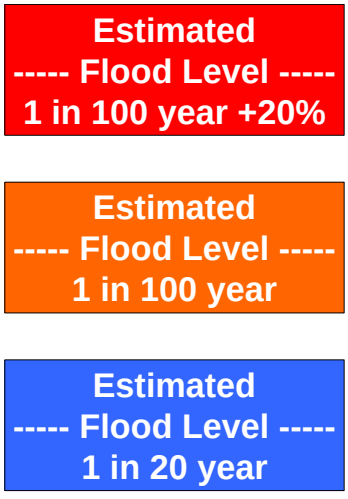


Figure 4.2.c: Applying flood levels on site using 'smart' GPS

This work was planned and supervised by our staff as seen in Figure 4.2.c. Specialist consultants were used for some of the detailed modelling. Each river system will have its own characteristics and therefore differing flood levels along its route.

Figure 4.2.d: Switchgear at risk of flooding

Figure 4.2.d demonstrates the effectiveness of our flood level assessment. It is clear, having installed the flood plates that this switch gear equipment is below the 1 in 100 year, and 1 in 100 flow +20% flood level events. This process has enabled us to act accordingly to ensure the site is not rendered inoperable during a flood event.

Our methodology decision making process used has considered the recommendations published in the various reports. The methodology employed is aligned with Ofwat's analytical framework, Service Risk Framework (SRF).

We have considered flooding in relation to the customers likely to be affected. While our initial assessment identified all of our sites that would be affected in the event of a flood of the 100 year + 20% flow scenario we have now reviewed the effect of these flood levels, and the subsequent asset failure, on the supply to our customers. In other words we have looked at flooding in terms of both likelihood and impact of the flood event.

For our assessment of the impact on customers we have used our 'criticality' assessments that form the basis of our capital maintenance planning. These assessments consider the population served by each asset; whether alternative supplies would be available and at what cost; and how long it would take to restore supplies by re-zoning, if available. The criticality assessments have been developed, however, on the assumption that single sites are affected independently of each other. This is unlikely to be the case in the event of flooding.

We feel that our customers are at low risk to flooding. Although floods at or near our sites are a distinct possibility it is unlikely that these events will cause supply to be lost and our customers will not be affected. The potential threat to our business operations caused by flooding has been considered in our future planning and work is currently underway to address this issue.

4.3 Reduction in Network Resilience

In order to meet our business aims of meeting demand for water and providing a product which meets quality control standards, we must ensure we provide a reliable network which adheres to regulation. This refers not only to the physical infrastructure i.e. pipe work, but to administrative functions across our region and the financial infrastructure on which our company is based.

Appendix C portrays the risk of a burst resulting in a loss of supply as more important than the previous issues mentioned in this Section. However, the potential for network resilience to be affected by climate change has been discussed last due to the uncertainties in the exact effect of climate change on increasing burst rates. The corporate risk; “Burst resulting in loss of supply due to ground movement” includes the consequences of climate change but does not separate them from other contributing factors. For this reason, the exact consequences of climate change on leakage are unknown.

In contrast, it is possible to quantify the effect of climate change on our supply/demand balance and on flooding in our region. As this section will describe, we are confident that climate change will affect our leakage rates and are confident in what way this will happen, but are in the process of researching methods to quantify these consequences of climate change on our network.

4.3.1 Burst Control

Our network itself is old. We know which pipes are most likely to fail because we keep good information about the age, condition and performance of our network. The older iron pipes, which make up about 70% of our network, are near the end of their economic lives and are vulnerable to bursting. Burst water mains are, by definition, unplanned and cause a disruption in supply; they also cause traffic jams, flooding, and risk of damage to the environment so we work diligently to reduce this impact on our customers.

A combination of combined corrosion effects, ground movement and thermal contraction and expansion mean that our pipes are susceptible to changes in the environment. Burst rates increase following prolonged hot and dry periods followed by wetter autumns, as was experienced in 2003.

We cannot continue operating as a business if we are unable to deliver water to our customers due to leakage. Currently, water lost through bursts does not threaten our supply demand balance, but as we have already seen, by the end of our planning horizon we anticipate demand to outstrip supply. It is therefore also important for us to reduce the effects of leakage in order to extend our supply capabilities. Responding to bursts is also a financially expensive exercise and so monitoring the possibility of a future increase in bursts can increase our financial resilience and avoid excessive financial burdens falling onto our customers.

We currently operate a well monitored and swift reactionary response process for finding and repairing bursts. Table 4.3.a illustrates the high level of active leakage control undertaken to meet our mandatory leakage targets.

Table 4.3.a: Total number of repairs

	Total Leaks		
Year	Reported	Detected	Total
2004-05	13,277	9,704	22,981
2005-06	12,961	17,179	30,140
2006-07	13,420	19,408	32,828
2007-08	12,297	19,823	32,120

4.3.1.1 Summary of Methodology Used

In a network of variable age, in widely differing ground conditions, leaks will occur. Around 70% of our network comprises old iron pipes, and these are particularly susceptible to bursts. Iron pipes cannot withstand, over the long term, both the corrosive and the distorting effects of the London Clay soils in our area. These clays can remain saturated long after substantial rainfall, while conditions on the surface may appear dry. So there may well be a situation where demand peaks (in dry conditions, high temperatures) at the same time as there is high leakage from a multitude of bursts due to ground movement and wet clay conditions below ground, referred to as a leakage outbreak.

Our current approach to leakage is determined by Ofwat and driven by the economic level of leakage (ELL). A least cost plan approach has been used to minimise operating costs in the short term and defer capital investment in the future. We consider achieving an adequate supply/ demand balance as a key part of our overall business strategy and will aim to continue to do this at an appropriate price.

Our Water Resources Management Plan explains the financial drivers for network leakage. Our assessment of the ELL is an important factor in demonstrating to our regulators and stakeholders that we are operating efficiently. We have selected the Modelling of Economic Leakage Targets (MELT) equations and the SALT model for our economic leakage appraisal. This approach allows us to include the deterioration of our network through the concept of Natural Rate of Rise in leakage (NRR) which we have defined following years of analysis by our engineers.

The younger the network the lower the NRR and our regions which contain a high proportion of plastic pipes such as PVC and MDPE have a lower NRR. The defined relationships have been applied to every leakage zone to estimate the total and detectable NRR for the whole company.Table 4.3.b is a summary of our detectable NRR by water resource zone and for the region as a whole.

Table 4.3.b: Natural Rate of Rise at company and at resource zone levels

Zone	Detectable NRR (Ml/d/year)
Northern Zone	15.2
Central Zone	27.4
Southern Zone	10.6
Company	53.2

Table 4.3.b effectively shows that leakage levels in our region could rise if action is not taken. However it is very difficult to isolate the rate of rise directly attributable to the effects of climate change. As the UKCP09 projections show, our region will experience more variable weather, with greater differences between wet and dry periods. This is likely to cause the shrinkage and swelling effect responsible for many bursts in our area. We do not, however, have quantifiable evidence which explicitly demonstrates the relationship between climate change and the shrink/swell phenomenon.

As we believe we are operating at the current ELL, and following the results of our corporate risk assessment, we do not believe that research to isolate the impact of climate change on leakage would be a great benefit to us at this time. However this is something that we will monitor and consider when necessary, and with accurate information on the direct relationship between climate change and movement of London Clay, we will be able to implement an appropriate adaptation plan.

4.3.1.2 Potential Impacts of Climate Change

We currently do not have accurate enough data, or computational methods, to predict to what degree weather scenarios will affect our network and so are therefore restricted to expert opinion and historical trends when planning our future approach. Variable weather patterns as a result of climate change may accentuate our burst rate due to the shrinkage and swelling of London Clay soil mentioned above. As we experience a more extreme difference between our wet and dry periods, so too may we experience a rise in bursts. It is important that we maintain our monitoring and analysis processes to ensure that bursts do not affect our stakeholders and business functions.

Bursts may become more of a financial concern and also contribute more negatively to the supply demand balance. As this report has shown, our future supply/demand balance is delicate and so efforts must also be made to ensure demand remains less than supply. Section 5 explains our proposed adaptation actions in more detail.

5 PROPOSED ADAPTATION ACTIONS

The following section outlines our proposed adaptation actions including the methodology used to ensure the adaptation action is appropriate. Due to the nature of our business, we are already in the advanced stages of many adaptation programmes, for this reason, a description of the work carried out so far is included with the planned works.

Where possible, information has been given explaining how our adaptation work has informed our approach and how further monitoring of the consequences of climate change will take place.

5.1 Adaptation to Water Scarcity

Here at Veolia Water Central, we take water efficiency to mean using less water, by using water wisely and reducing water wastage. Managing demand is good for sustainability and avoids the need for any additional impact on the water environment and reduces greenhouse gas emissions through energy saved from pumping. Our Water Resources Management Plan explains that we do not take water efficiency to mean restricting or reducing the use of water appliances (for example by showering less or not watering the lawn at all).

5.1.1 Current Actions

We have a range of current efficiency operations, as outlined in our Water Resources Management Plan and hope to continue our current strong performance in this topic through a number of proposed schemes.

Much of our water efficiency work revolves around influencing user behaviour. We propose to continue to put emphasis on carrying out customer research in order to understand our customer's motivations and water efficiency behaviours. Our findings will be communicated through our strategic partnerships with influencers and policy advisors so that they begin to promote credible and appropriate water efficiency measures. We work towards ensuring that our water efficiency operations have a lasting effect and help reduce demand therefore increasing resilience in periods of low supply.

Our main driver for water efficiency operations is our regulatory authority Ofwat. We aim to work closely with them on all our water efficiency schemes and through their guidance are able to form effective cost-benefit analysis of appropriate projects. For more details on our cost benefit analysis methodology, see our Business Plan.

5.1.2 Proposed Action to Adapt to the Effects of Climate Change

Demand in our region is expected to rise due mostly to a population increase driven by economic reasons but also because of weather changes due to climate change. We have considered this in our supply/demand analysis as shown in our Water Resources Management Plan, but also consider the effect our water efficiency program will have on individual consumption.

All water efficiency activities require measurement of both the costs and benefits in order to assess their effectiveness compared to other supply/demand measures. We played an active role in the recent UKWIR research project, *"Quantification of the Savings, Costs and Benefits of Water Efficiency"* and we will carry out water efficiency activity in accordance with these best practice guidelines. We are committed to researching new and alternative ways to save water and promote efficiency. Our research is a direct benefit to not only ourselves, but the industry as a whole.

5.1.2.1 Education

We plan to extend the information and education service we provide to all our customers, domestic and commercial. We will encourage customers to use tap water efficiently in the home by providing them with more information on the availability and use of water efficient devices, which can be fitted into either new or existing homes. We know that 25% of the homes in our region will be refurbished over the next 25 years, so there is considerable scope to retrofit water efficient devices and appliances helping to make water efficiency part of everyone's lives.

Our wide range of proposed educational water efficiency schemes are explained in more detail on our website [2] and Water Resources Management Plan.

5.1.2.2 Water Tariffs

Between 2010 and 2015 we intend to carry out trials of new methods of charging for water, such as a higher charge for using water during the summer months when it is scarcer. This is a topic which is currently being explored but we are currently unable to quantify to what extent this will reduce load on our supply/demand balance. This option is explored in more detail in our Water Resources Management Plan and will be considered and explored more thoroughly as and when necessary.

5.1.2.3 Metering

Metering is proven to reduce demand with average consumption for metered customers in our region equating to around 154 litres/day compared to 178 litres/day for unmetered. Metering educates the customer on their water consumption and raises awareness of excessive use. It is in the customer's best interest to lower their demand when metered and so therefore we expect a highly metered population to be more water efficient than unmetered and therefore reduce the strain on our supply/demand balance.

If at least 90% of our customers were to have water meters, we could measure usage and patterns of usage more accurately, allowing us to manage demand more effectively. Currently, only about 40% of our customers have a meter installed. From the industry's experience with metering, we know that customers tend to use, on average, 10% to 15% less water than if unmeasured. Meters also allow us to charge on a pay-as-you-take basis, which the majority of customers believe is a fairer basis for charging.

Ofwat have recently deferred our compulsory metering programme. After 2014 we will resume metering of households on a geographical basis, either in conjunction with our programme of mains renewal to minimise overall disruption, or prioritised by degree of local water stress. Metering in this way means we can reduce the cost of installing meters. Our strategy, as explained in our Water Resources Management Plan, means we aim to complete around 90% of meter installations by 2030. The remaining 10% of properties would, so far as economically possible, be metered in the longer term.

We feel that compulsory metering is at present, not a necessity in order to guarantee supply and wish to allow our customers to make their own decisions on metering. However, our future supply predictions show that demand may outstrip supply by the end of our planning horizon and so the idea of compulsory metering could be become a reality in 21st century. Compulsory restriction orders, and reliability on emergency supplies at this point would become more common and the price of meeting demand would rise.

[2] https://central.veoliawater.co.uk/

As with all water resources projects, monitoring will take place periodically for our Water Resources Management Plans. By adapting our water efficiency approach in the future with compulsory metering, we can potentially reduce demand and therefore not have to develop new sources – a process which has additional adverse ecological impacts.

5.1.2.4 Water Efficiency Operations

In its publication *Future Water*, DEFRA announced an aspiration to achieve an average per capita consumption (PCC) of 130 litres/day national average by 2030 for our metered population.

We have reviewed how it may be possible to achieve this goal together with the ballpark costs (see Table 5.1.a) of attaining it utilising an assessment of the impact of tariffs and the measures required to reduce the volumes of micro components contributing to PCC.

Table 5.1.a: Costs of reductions in PCC

Micro Component	New volume (l/use)	New PCC	Change in PCC (l/p/d)	How to get new volumes?	Costs millions
Bath	70	146.5	1.8	Subsidy to replace bath with smaller more water efficient fittings. Allow £300 per bath to include liaison with bathroom supplies and fitters.	195
Power shower	80	140.4	6.1	Distributing and fitting aerated showerheads. Fitting service and test to verify reductions in flow rate at £80 per showerhead.	20
Normal Shower	42	138.9	1.5	Fit flow restrictions, shower timers, increased publicity, flow shut off devices.	65
Washing Machine	45	137.5	1.4	Trade in and subsidies for all washing machine replacement. £150 per machine plus admin and overheads.	110
Dishwasher	15.5	137.0	0.5	Trade in and subsidies for all washing machine replacement. £80 per machine plus admin and overheads at 10%	13
Dual Flush Toilet	4.5	132.3	4.7	Replace older toilets for free plus plumbing services including for fitting.	55

We co-ordinate and manage our water efficiency programme through our Water Efficiency Programme Manager and we will establish a framework for setting project objectives and monitoring performance against those objectives in terms of activities, costs and water volume saved. This will ensure that water efficiency is closely aligned with the regulatory process.

We will also continue to participate in such groups as the Water UK Water Efficiency Network, The EA, Anglian Region Water Efficiency Group, The National Water Conservation Group, the Imperial College led WaND project and the Watersave network. We will also work closely with our regulators as well as industry organisations such as Waterwise.

Our continued support of industry and academic R&D groups is fundamental in order for the water sector to understand the issues involved in promoting water efficiency nationally on a larger scale. This also benefits the sharing of information and best practice throughout the industry and associated parties.

In the best interests of our customers we will, as an environmental measure, lobby for change in building regulations and in the regulations governing domestic appliances and their installation. We will also call for tighter regulation on equipment and on the adoption of measures to adapt to climate change.

Our regulatory requirements involve continuously updating our relevant Plans, and we feel that this is the most appropriate manner in which to monitor and communicate progress in this sector. Our approach to this topic is one of continuous adaptation and we feel that our response framework is currently well prepared to evolve to new challenges or to regulatory requirements.

5.1.2.5 Efficient Management of Supply

In planning for both supply and demand we prefer to manage our supply efficiently rather than rely solely on demand operations. This is because demand measures require reductions in consumption and there is considerable uncertainty whether savings will endure into the future. We consider that water metering and the implementation of tariff measures alone are not enough for the promotion of water efficiency however water efficiency schemes go through the same robust project screening and economic appraisal as other water resources projects.

We propose investment in the new regional Abingdon Reservoir (Oxfordshire), shared with Thames Water, in order to collect and store winter rainfall to supplement summer flows in the River Thames. This will boost the capacity to meet summer demand. We are continuing our investigations with Anglian Water to increase our import of water from Grafham Water Reservoir near Huntingdon, and we are also exploring development of new resources in the confined chalk aquifer under the London urban area. Lastly, we will be working with the Environment Agency and the other water companies in the South East to promote other new strategic transfers into our area.

We hope in the future to maintain our leading position within the industry and aim to do this by adapting now to climate change. We will ensure we remain competitive by consistently measuring our performance against other water companies in the South East of England using audited and published data. We will seek to challenge and better previously set targets on an annual basis to continuously improve when compared to previous years.

Through our periodic Plans we will monitor progress of all water management projects. This will allow us to communicate our progress to not only our regulators but internally and to our stakeholders. We will also be able to periodically review our adaptation measures and adapt them if necessary.

5.2 Adaptation to Flood Risk

Flooding has the potential to affect not only our physical assets, but to the quality of the water we supply. We take the flooding very seriously and plan accordingly. We constantly update our flood plans to ensure they remain effective but we will work closely with the Environment Agency to ensure interdependent sites implement adequate flood protection measures. Interdependent sites and facilities are those not belonging to us but of consequence to our operations, i.e. around power generation facilities etc.

5.2.1 Current Actions

Through on site surveys and subsequent decision making processes mentioned in this report and our Business Plan, we have determined the designs and costs for physical mitigation

measures. Each of our sites, because of their unique layout and topography require a tailored solution. Our protection measures fall into generic categories listed below:

- *Bunds* – Where it is more economic to protect a group of assets, rather than multiple single assets then a bund is our preferred solution. With any bunded solution comes the additional requirement for sealing, drainage and access.

- *Doors* – Where flood levels are not excessive and assets can be protected within a building, then we have used removable 'stop plates' across doors. Although these will be stored by each door, they will need to be deployed upon warning of a flood. These procedures will form part of the emergency plan and maintenance programme. Figure 5.2.d is an example of this from one of our facilities.

- *Ducts* – To maintain water tightness all ducts carrying cable, pipes etc must be sealed. These will be secured by inspection and the use of expanding foams.

- *Pumps* – Bunded areas will require a new sump pump system and automatic controls. Where sump pumps already exist for operational purposes, these will be replaced with larger pumps where appropriate.

- *Raise* – Where specific plant can be raised above anticipated flood levels without affecting it's operation then raising is our preferred solution as most of our equipment will not generally be waterproofed to a submersible rating to enable it to operate underwater. Most of the plant recommended for raising are our electrical transformers. Figure 5.2.a is an example of this.

- *Raise electrical equipment* – As above but applied to plant owned by the electrical supply company. Figure 5.2.b is an example of this.

- *Seal wells* – Some of our boreholes were found to have openings or seals not in place and that require resealing.

- *Access* – Where bunds are used, access is impeded so ramps have been provided in the designs.

- *Minor items* – including sufficient stocks of waders and sandbags.

Where the local electricity supply company advised there could be possible failures caused by flooding of their plant on our property, fixed standby generators have been included in the designs. Access to some of our sites during flooding has proved difficult to achieve in the past so 'waterproofed' vehicles and inflatable boats have been included.

Figure 5.2.a: Example of raised Transformer

Figure 5.2.b: Example of raised control equipment

Figure 5.2.c: A previously raised pump now requiring additional protection to adapt for a climate change scenario.

Figure 5.2.d: Example of a high security access door where a 'stop plate' will be installed inside the building, allowing access with security.

5.2.2 Proposed Action To Adapt to the Effects of Climate Change

Since 2008 various reports and recommendations have been made, in particular the Environment Agency is now producing maps in response to the *Pitt Review*, recommendation 2. These maps have been used to confirm sites at risk.

We commissioned a review by independent consultants Jacobs of designs and costs to test the resilience levels provided by our existing solutions. The review has identified additional items of work such as waterproof rendering to buildings, access over bunds, including automatic gates, rain drainage with tidal flap valves, a more detailed specification for sump pumps with pipe work and more detailed assessment of ducts or airbricks to be sealed. This additional work has resulted in an average increase of 50% in costs, which has been applied to all sites in our Plan.

Work has started on adaptation of our emergency plan including general procedures in response to flood warnings. These include site specific action plans where active interventions are required such as door plates.

In light of the Pitt Review into the 2007 floods, we are reviewing the susceptibility of key assets and infrastructure to extreme weather events. The need to move or replace assets affected by flooding and coastal realignment will also be addressed. Economic investment proposals are included in the business plans for 2010-15 and beyond.

Table 5.2.a, from our June Return, summarises our flooding resilience project.

Table 5.2.a: Flood adaptation project summary

<table>
<tr><td colspan="2">Project title:
Resilience to flooding</td><td>Project reference number:
EALL SI15006</td></tr>
<tr><td colspan="2">What is the problem?
The floods of 2007 showed the vulnerability of the national infrastructure
Our assets need to be protected against the flood effects of climate change
We need to comply with Ofwat, Defra, Environment Agency and Pitt Review requirements and recommendations</td><td>What is the solution?
We need to provide flood protection at critical sites, including bunds, door plates, raising equipment, sump pumps and sealing ducts
We will adapt our emergency plan to respond to flood warnings.</td></tr>
<tr><td colspan="3">When does this project need to be complete and why?
There is no regulatory completion date but we believe this work should be completed by 2015</td></tr>
<tr><td colspan="3">Costs:</td></tr>
<tr><td colspan="2">Capital cost to complete project:
[redacted]</td><td>Operating cost following project completion: £0 /annum
Minimal for exercising and maintenance</td></tr>
<tr><td colspan="3">How have these costs been identified?
Used Ofwat’s Service Risk Framework methodology (SRF)
Used Environment Agency’s Flood Maps for the climate change scenario (1:100 year return period plus 20% Flow)
Consultants (Jacobs) used to define sites at risk using EA flood risk maps and Jacobs experience for protection works and costs
Covered fluvial (river), pluvial (rain) and groundwater flood risks
109 sites identified and visited to survey risk and protection works
48 sites identified as requiring protection works .
29 sites identified after criticality and cost benefit analysis</td></tr>
<tr><td>Is this project cost-beneficial?
Yes, clearly supported by cost benefit analysis.</td><td colspan="2">If this project is not cost-beneficial why is it being included in the proposed investment plan?
Ofwat expectation following Defra and the Pitt Review</td></tr>
<tr><td colspan="3">What is the effect of this project on the embedded and operating carbon footprint?</td></tr>
<tr><td colspan="2">Embedded carbon: 1075 t CO2(e)</td><td>Operating carbon: Zero kg CO2(e)/annum
Insignificant for exercising and maintenance</td></tr>
</table>

As mentioned, flooding may also have consequences for our water quality. In response to this issue we have secured the use of some bank side storage as protection against short term pollution of the River Thames. Water stored can be used as an emergency source for blending with our river water when polluted such as at times of high nitrate concentration. The lakes have no significant impact on drought deployable output and would be used only for water quality purposes.

Further research is being undertaken in cooperation with UKWIR to assess potential adaptation actions to combat against the possible effects climate change may have on our water quality.

In past years, flooding of sites has occurred but has not resulted in failure of supply and only minimal damage to plant which could be resolved with some remedial works. Design changes have been incorporated in order to increase resilience to flooding. Flooding brought about by climate change will continue to cause damage and disruption to operations but due to our research and adaptation programme, we do not believe it will affect our customer's supply.

5.3 Improving Network Resilience

5.3.1 Reducing Impact of Bursts

Leakage reduction has been a significant priority for us in order to meet our regulatory requirements and contain the demand for water. As this report has outlined, the UKCP09 projections for climate change could have consequences on our supply demand balance before the end of our planning horizon. Mending a leak increases supply and reduces demand. Despite the enormous progress we have achieved over the past 15 years to contain leakage, we plan to keep leakage containment and reduction as a key priority for the company over the long term.

This report has highlighted the importance of water efficiency operations in the effort to reduce the impact from potential water shortages in the future. Leakage targets are legally binding and highly publicised. Failure to meet such targets may result in financial penalties but crucially, when looked at in the context of climate change, places unnecessary strain on the supply/demand balance.

5.3.1.1 Current Actions

Our research programme helps us understand leakage in our area and the effect of investment on future levels of leakage. A vital concept when forecasting investment required to reduce leakage is the natural rate of rise of leakage (NRR). NRR is the rate of increase in leakage if no investment is made. Following one of the most extensive NRR research studies carried out by any company in the UK, we are rapidly increasing our understanding of the link between network deterioration investment and leakage. Our results are detailed in our Water Resources Management Plan and our Business Plan. This knowledge will inform our leakage strategy and will show that due to the effects of climate change, our efforts to reduce leakage will have financial as well as environmental benefits.

The regulatory framework promotes repairs on the network to the point that repairing a leak or series of leaks costs no more than developing a new water source. In current industry terms, this is the Economic Level of Leakage (ELL); it is a consistent approach throughout the water industry and will continue to drive our work. We feel that with our increased research in this area, and the development of our network modelling capabilities, leakage levels will be kept at a respectable level in the future and will remain resilient to the effects of climate change.

Despite this, we will, over the next 25 years, ensure that in dealing with issues of supply and demand, leakage does not rise above the ELL. Together with OFWAT and the Environment Agency we are exploring the possibility of recalibrating the Economic Level of Leakage. The network that we have is the legacy of previous generations; we have to make sure that over the next 25 years the network is renewed, maintained, and passed on in good working order. As experience proves, our older pipes in the network are prone to bursts which cause large amounts of wasted water, as well as energy and financial costs associated with finding and repairing leaks.

5.3.1.2 Proposed Action to Adapt to the Effects of Climate Change

Sufficient headroom is required in our supply/demand balance to accommodate demand when leakage outbreaks occur and are brought under control. We strive to engage our customers in identifying leaks that we might not be aware of, so saving water and mitigating damage. We continue to invest in new technology, providing better and faster information, to respond more efficiently to leaks identified by customers. However, customers may need to be encouraged to see beyond the leaking water main to realise that if we tackle every leak in the future by applying a standard beyond that of the Economic Level of Leakage, then we will have to increase water charges.

It is possible beyond our planning horizon that demand is so high, and tolerance for leakage so low, that these factors will be seen as more important than economic ones, and leakage may then be addressed irrespective of cost to the company and to the customer. We currently have no reason to suspect this will happen but its possible that climate change may have consequences on our water resources to this degree at some point.

Our Water Resources Management explains in detail that we know broadly (and would know more accurately through appropriate metering) that around a third of all leakage takes place on our customers' property. Metering at the boundary of a customer's property helps our customers identify leakage and encourages them to take action to have repairs done, as they pay for the water that is lost from their pipes. It might also reduce damage, and potentially help indicate lower level leaks than are currently detectable.

We hope to continue our efforts in offering free meters to customers who request them whilst also continuing compulsory metering for new builds. We will also work to re-introduce compulsory metering in properties at change of ownership which was recently ruled out by Ofwat for financial reasons. This report has shown that metering reduces PCC but metering is also an important consumption monitoring tool and we feel that in the best interests of our customer's this topic requires re-examining by us and our regulators.

In our area we offer free repair of customers' pipes, and we subsidise a renewal scheme to replace old or unreliable pipes on customers' property; this encourages owners to take the necessary action. But over the next 25 years, to make real progress with this important component of leakage, it is possible that many water companies will take some form of responsibility for the customers' supply pipes from the boundary stopcock to the point of entry into their property. Such an involvement by us might entail a greater subsidy for customers to repair their leakage, or wider use of our expertise. We are currently exploring this option and are successfully educating customers on the importance of finding and fixing leaks on their own property by offering financial incentives to do so. In time this will reduce demand and increase the time needed before development of new water sources is necessary.

We will make use of new technical advancements now coming to market to locate and fix leaks more quickly. Already we are extending our coverage of noise "listening" devices on our network to identify leaks and initiate repairs quicker. We will maintain and extend our District Metered Areas, small zoned and metered areas where we can measure usage and leakage precisely. We regulate water pressure in the network to reduce and control leakage, whilst maintaining levels of service expected by our customers. Our innovative management system, using hydraulic models, will ensure that water pressures and therefore leakage can be reduced outside peak demand periods.

We will continue to renew our mains pipes at the current rate (1 in 100 years replacement) or higher where this can be justified to our economic regulator, Ofwat. We will work with Ofwat

on a programme to replace communication pipes (which run between the mains and the customer's property) at the same time as mains are renewed. Environmental accounting and climate change will alter the risk-based and historical approaches to the way we renew pipes and plant during the next 25 years. We will need to calculate and show an appropriate rate of renewal in the future together with an appropriate strategy for mains repairs. In essence, environmental accounting will change the point at which, instead of deciding to repair failing pipes, we will renew the water main along its entire length. This promises to offer the customer better value for money and increase our stakeholders confidence in our financial operations.

6 UNCERTAINTIES

As the recent report by PricewaterhouseCoopers LLP (*Adapting to Climate Change in the Infrastructure Sectors: Maintaining robust and resilient infrastructure systems in the energy, transport, water and ICT sectors*) highlights that the water industry is generally well informed on the physical effects of climate change. We are considered one of the leading sectors in preparing for, and adapting to, climate change and believe that we are adequately aware of the consequences and appropriate actions needed. However, there are many aspects of climate change adaptation beyond our control which remain unexplored and areas in which uncertainties exist.

This report has outlined the uncertainties in many of our approaches and risk assessment methodologies and explains, where known, the doubt in our assumptions. We are in a position to cooperate and work with other water companies in the UK in order to improve our research and evidence base. However, there are a number of other aspects which we as a sector require more information on if we are to develop a completely accurate adaptation plan.

Uncertainty should not be a reason for inaction. Our adaptive management allows for adjustments, as additional and better information becomes available. Adaptive management requires continuous feedback and adjustments based on the information provided by our monitoring networks.

6.1 Legal and Regulatory Uncertainties

The evolution of the structure and shape of water regulation over the next 25 years is difficult to predict. We hope for new approaches, including more co and self-regulation, greater regard for variations in risk, increased regulatory consistency and long-term clarity, and less micro-management by regulators. We hope to work closer with our financial regulator Ofwat, in order to reduce the adverse threat of uncertainty in the way our industry is regulated in the future. We hope that by working together with our regulators towards a unifying goal of adaptation, we will be able to overcome barriers posed by our regulators and introduce adaptation programmes in the best interests of ourselves and our stakeholders.

In assessing risks and developing our plan for adaptation we have made the assumptions mentioned in this report. We have worked on the basis that legal, financial, and regulatory restrictions placed on us will not change beyond the parameters discussed in our Business Plan and Water Resources Management Plan. Where we foresee a future difference to current practice we have included this in our planning. Unfortunately, there is very little else that can be done to mitigate the uncertainties arising through regulatory, financial, and legal changes throughout our planning horizon, but through our constant monitoring and evaluation of our approach (in the form of our Plans) we can ensure these uncertainties are addressed when information becomes available.

6.2 Data Reliability

Data used during our risk assessments as well as for our proposed adaptation programs include a certain degree of uncertainty. With specific regards to our supply/demand balance this has been modelled in our headroom and explained in more detail in the relevant sections of our Water Resources Management Plan. For example, within our area, reliable groundwater hydrographs are only available from the early 1970's onwards, and so do not provide us with a longer term picture.

We use Meteorological Office Rainfall records in the form of MORECS data, which give weekly values for a variety of meteorological parameters. This data is available from 1962, thus is inadequate for long term statistical analysis. At present the industry consider it the most accurate data available, but only time will tell whether or not industry assumptions are correct.

We have developed our adaptation program to be flexible in order for uncertainties in our risk assessment to be accommodated. With specific regards to our flood adaptation program, we have improved resilience despite having never lost supply due to an extreme flood event. We would be able to produce more accurate and therefore more effective adaptation programs if we could be guaranteed accurate and reliable data.

Although we are not alone in using the external data sets as detailed in our Water Resources Management Plan, we do recognise that their reliability and accuracy is not guaranteed. With more accurate data we may arrive at different conclusions which force us to alter our adaptation program. We are statutorily obliged to produce updated Plans ever 5 years and so through this mechanism we are able to constantly monitor up to date published data and re-evaluate our risks due to climate change.

6.3 Water Quality

As a business, we are regulated by not only Ofwat but also by the Drinking Water Inspectorate (DWI) who monitor the quality of water in our supply. Water companies which fail to meet quality standards can face legal action, financial penalties and additional costs associated with the work to correct the fault. Water quality is a serious issue with many water borne illnesses being potentially life threatening.

We are unable to function as a business unless we can provide water which meets quality control standards. Contamination of supply can also affect the aesthetic standard of our water reducing customer's confidence in our ability to provide a safe product.

We work diligently to ensure our product is of the highest quality and have an exceptional safety record. However, there are many unknowns currently with the precise effects of climate change on our water quality.

We understand that higher water temperatures and changes in the timing, intensity, and duration of precipitation can affect water quality but cannot effectively quantify the effect climate change may have. Where stream flow and surface water levels fall, there will be less dilution of pollutants; however, the IPCC point out that increased frequency and intensity of rainfall will produce more pollution and sedimentation due to runoff.

Water UK, in their summary of how the water industry needs to adapt (*Water UK: How the Water Industry is Adapting to Climate Change, Dec 2008)*, confirm that lower river flows will reduce the dilution of wastewater effluent. We may need additional treatment to meet higher standards, which are likely to be achievable only by using energy-intensive processes, with all that means for greenhouse gas emissions. Colour and odour problems will result from higher temperatures and more intense rainfall events.

The IPCC continue to describe how flood magnitudes and frequencies will very likely increase in most regions, mainly as a result of increased precipitation intensity and variability. Flooding can affect water quality, as large volumes of water can transport contaminants into water bodies and also overload storm and wastewater systems.

Our current strategy for managing water quality issues involves catchment and on-site surveys as well as pollution risk assessments (PRAs). The PRA draws on a range of data including land use, hydrogeological conditions and both headworks assessments and downhole inspections to calculate the relative risk of a pollutant occurring in the raw water at a public water supply borehole. These PRA's have been incorporated into Drinking Water Safety Plans (DWSP) to provide a rigorous, quantifiable risk based assessment on which monitoring requirements, risk mitigation, treatment methods and future investment can be based.

We consider the risk of changing water quality seriously and from these studies we are able to predict long term trends in water quality and so therefore are confident that we can guarantee future water quality.

A UKWIR report, *Climate Change Implications for Water Treatment,* due to be published in February 2011, will use baseline and future projections of water quality simulated using the following models:

- SIMCAT (a river water quality model developed by the Environment Agency)
- ILC (Integrated Lake and Catchment model, able of simulating both river and lake water quality)
- INCA (Integrated Nitrogen model for multiple source assessment in Catchments)

Using the findings of this report we will begin to understand the consequences of climate change on water quality and plan effectively for future effects. At present we cannot say with any certainty how much of a risk climate change is to our product quality.

In the future we hope to be able to guarantee safe clean drinking water regardless of any consequences of climate change, therefore the uncertainty of our capacity to supply a potable supply is of high concern and will be need to be highlighted in future projects. We currently do not know enough to generate specific adaptation actions but will continue to work across the industry to research this topic.

6.4 Effects of Climate Change

We have developed our adaptation program in line with current identified risks however many of the actual physical effects of climate change remain unknown. We have used the UKCP09 projections and are confident that there will be changes in weather and climate but it is impossible to accurately predict what this changing weather will be, and to what degree it will affect business operations. Due to the enormous quantities of unknowns in this area, we see our safest course of action at present is to increase resilience across large areas of the business where potential consequences of climate change have been identified so that we will be able to adapt in the future when effects become certainties.

For example, we have assessed the likelihood of, and planned for both drought and flooding as well as for increased temperatures and decreased temperatures. The UKCP09 projections are the most reliable data sets with regard to climate predictions in our area, but these will need constant monitoring and updating to ensure our periodic Plans remain accurate.

It is also almost impossible to accurately differentiate between changing weather patterns and behaviours, and adverse effects which are as a direct result of climate change. Variable weather may be a possible symptom of climate change but it is unknown to what extent it

may have been as a direct result of. Our current risk assessment methodology considers all effects of changing weather and not just climate change independently. This approach has so far proved effective in ensuring we fulfil our business functions. It may become apparent in the future however that this approach requires adapting and a more climate change focussed methodology is necessary.

Years of data will help us to prove that weather events such as floods and droughts are becoming more common because of climate change, and would not have just occurred anyway. Being able to clearly identify the risks due to climate change alone will also allow us to assign an associated financial cost. This will allow us to justify our operations to not only our economic regulator but to our customers as well.

We feel that by considering the worst case scenarios detailed in the UKCP09 projections, we will be adequately prepared should discrepancies in the data emerge. We may find that climate change effects that we had previously not considered may bring new consequences for our operations, or identified effects may develop into more serious issues. We will be in a position to adapt having already deeply embedded a high level of resilience in our company operations. Our risk assessment methodologies and plans for adaptation are flexible and we believe that despite being aware of potentially inaccurate data, feel that we are adequately prepared.

6.5 Risks to Administrative Operations

Like any organisation, we need to ensure that we have the facilities and systems in place to support our activities. We also have a legal requirement to be able to deliver certain critical services at all times, such as emergency provisions for water. To do this we need appropriate buildings, equipment and vehicles and relevant protocols to safeguard our staff and stakeholders.

Our current risk assessment methodology assesses the effect weather may have on our operational capacities. Adverse weather conditions not only create a dangerous working environment but are recognised to reduce work output. We must comply with our duties under Regulation 3 of the Management of Health and Safety at Work Regulations 1999.

We do not currently have a set methodology specifically designed towards assessing how climate change may affect our operational capabilities in the future. However we make use of expert analysis of published reports and historical precedent to ensure our administrative functions remain resilient.

Important industries to our administrative functions, such as telecommunications, transport and energy transmission, are due to publish their adaptation reports throughout the reporting process. These documents will allow us to make informed decisions on the quantifiable risk to our business due to climate change.

Power failures are a distinct possible effect of climate change; without power, our administrative capabilities will be limited. Following the publication of the adaptation reports from the energy sector, we will be able to more accurately quantify how our administrative functions will be affected by energy failure.

Due to the nature of our business, many of our operational sites are in rural areas and so adverse weather conditions may hamper our efforts to access assets. Access to urban facilities, such as our head office, may also become more difficult for staff. PricewaterhouseCoopers LLP sector summary on transport identifies 80 highways agency activities which may be at risk of climate change, and points towards a future where the

reliability of our roads network is not guaranteed. Rail connections are also at risk according to the report, with particular mention made to the effect of flooding. We will have to re-evaluate this issue following the publication of the transport sector adaptation reports.

Our business is heavily reliant on information and communication technology to help us monitor, and maintain our network. The PricewaterhouseCoopers LLP report states that due to the nature of the communications industry, long term planning for climate change is not a priority. However, there is an overall recognition that many communications infrastructure assets are exposed to weather related disruption. The dependence of many other sectors on ICT also means that extreme weather events could place strains on the capacity of the networks. The exact nature of this risk will become more apparent following publication of adaptation reports from this sector.

To help ensure we remain fully operational we have recently introduced flexible working hours and facilitate our staff members to work at home. This will help our staff continue to work in the event of adverse weather conditions and ensure our service to our customers remains unaffected.

7 BARRIERS TO ADAPTATION

7.1 Regulation and Legislation

We expect the legal and regulatory requirements which we meet to become more onerous. This is not simply a question of requirements in respect of drinking water. We expect new national and international requirements to mitigate climate change, implying limitations on carbon emissions. The form that new legal requirements will take is currently unknown. For example, recent changes in the Carbon Reduction Commitment (CRC) have altered the way we include carbon emissions in our financial approach.

Limitations on abstraction of water for public supply from the Environment Agency are likely to become more stringent, in part as a result of progressive tightening under the Water Framework Directive. It is worth noting, however, that our adaptation program is only appropriate under currently advised sustainability reductions up to 2015 and we have been prevented from including a quantum of wider resource loss post 2015 in our long term planning, creating an amount of uncertainty. This uncertainty has been modelled in our headroom and we feel that we are in good position to monitor and re-assess this situation through publication of our Water Resources Management Plan.

7.2 Resources

Some of the adaptation activities involve making high cost investments today to adapt to impacts that may not be realised within the typical 25 year horizon it plans for. To a large extent, the periodic nature of the 5 year price review process, within the context of a 25-year horizon, lends itself to a phased response to adaptation. In theory this is broadly consistent with prioritising investments, and should lead to the adoption of a strategy which avoids large commitments during periods of uncertainties by offering the flexibility to make deferred decisions.

In practice when set against the criteria of value for money, Ofwat need to consider the impact on customers' bills and consumers' willingness to pay. Climate change adaptation is not considered in our customer's willingness to pay studies and for this reason it may be difficult to justify these investments to Ofwat. To overcome this, we will continue to work closely with other water companies and organisations, regulators, and our customers in order to ensure that Ofwat are acting in our customer's best interests.

We will need years of experience to form an effective methodology for choosing investments but we will also need to work closely with the industry to achieve this. Ofwat have been pushing for a more transparent and considerate investment approach and it is hoped that the financial implications of climate change will motivate our industry to improve in this topic.

7.3 Knowledge

Uncertainties associated with the UKCP09 projections and with other data mentioned in this report may make development of effective adaptation strategies difficult. In order to retain investor confidence to justify large scale investments, and to be sure we are acting in the best interests of our customers, we require a reliable evidence base.

We use the most reliable evidence bases available to us and cooperate with the Environment Agency, Defra, and all our regulators in our research. We will continually update and evaluate our Plans through the periodic reporting process and so will be in a position to act when future risks are identified and justification for adaptation actions found. Through this research we will reduce uncertainty and barriers to adaptation.

7.4 Interdependencies and Stakeholders

We rely heavily on a number of other key industries and authorities. For example, installation of flood resilience at our facilities to protect them against 1 in 100 year plus 20% flows in rivers is undermined if flood defences at power generating sites which supply us with electricity for pumping and water treatment are poor. For this reason although we can move to increase resilience of our business, the benefits of this investment will not materialise if other stakeholders do not invest similarly. In order to overcome this we will work with our interdependencies and regulators such as the Environment Agency to ensure that our adaptation actions remain appropriate. It is hoped that one of the outcomes from the first UK national adaptation programme will be reassurance that all important industries are equally well prepared for the effects of climate change.

We work closely with the Environment Agency who, like us, are in favour of the promotion of demand management, leakage reduction, water efficiency and metering to reduce increases in demand so that more water may be left in the environment. However these initiatives are not economic or cost beneficial compared to increasing water resources. The Environment Agency has specifically excluded us from including order of magnitude costs for sustainability reductions required to deliver the Water Framework Directive requirements in our Water Resources Management Plans. This makes it difficult in turn for us to justify demand management measures on economic grounds.

We will continue to work with stakeholders, conduct willingness to pay surveys and undertake research in this area to determine the amount extra customers are willing to pay for climate change adaptation projects. We will work closely with others on whom we depend and with those who depend on us on the subject of climate change adaptation and feel that the requirement for preparing statutory adaptation plans will enable closer cooperation on climate change issues. We will work with Defra to help facilitate cooperation across key infrastructure and utility owners.

Power cuts could become common as weather conditions cause failures across the energy transmission sector. This, combined with potential future power shortages, will affect the way we pump water across our network. At present, night time pumping is employed to take advantage of reduced energy costs, but if energy tariffs change, more intensive pumping during periods of lower cost will place huge strain on equipment and the network which may not currently have a high enough peak capacity to cope. Also, our current network of pumps is energy efficient providing water supply levels remain within certain parameters.

We currently have no plans to introduce micro generation capabilities sufficient to compensate for power cuts, and so will rely heavily on the resilience of our energy suppliers. If the energy industry is not appropriately prepared for the future then we will be affected as a result.

8 MONITORING AND CONCLUSION

Changing weather brought on by climate change will directly affect our organisation in a number of ways, but it is only through our continued monitoring and research that we can be sure that any proposed adaptation actions are appropriate. Our studies which contribute towards our future planning consider all environmental considerations and climate change has been a part of that for a long time. This report has shown that while we are well prepared for the effects of climate change until the end of our planning horizon, this resilience was not brought about by considering climate change as a specific risk to our organisation.

It is likely that with more adverse weather conditions, we will face new challenges, ones which until now have not been standard occurrences in our region for example, large-scale flood events and droughts. This apparent contradiction highlights the issue of how important knowledge of the actual physical effects of climate change will be and we will continue our efforts to increase our understanding in this topic.

We have, and will continue to prepare for whatever environmental conditions climate change will bring. We have extensively studied various climate models, including the UKCP09 projections from UKCIP but also include historical data and expert opinion wherever possible By embedding climate change adaptation in our organisation we anticipate that we will continue to function effectively in this region and will have the knowledge and experience to adapt to suit our changing environment.

8.1 VWC and Climate Change

We feel that our current system of operating should serve us well when adapting to climate change in the future. It is flexible enough to respond to any current plausible weather scenario and as this report has shown, effective at identifying changing conditions within our planning horizon. Through our periodic Plans we are able to continue communicating our findings concerning future conditions to our stakeholders and our own staff. Monitoring and preparing for the consequences of climate change is part of our usual planning and this report has shown how our current methodologies and approach is effective.

We aim to take into account worst case scenarios in our planning wherever possible, as our approach to water resources management shows, and feel that our current abstraction and operational methods should be an appropriate framework from which to implement adaptation actions.

As a water company, we are already in the process of adapting to the effects of climate change and feel that the industry as a whole is well informed of the environmental changes we face. We devote a considerable amount of resources to monitoring the effects of changing weather patterns and believe that our planning approach is justified and well researched. We operate in an area of significant water scarcity and it is for this reason that we consider our future planning very seriously.

8.2 PACT

PACT (Policy Action on Climate Toolkit) is a web based self assessed, but expertly moderated framework questionnaire, used by organisations to identify current company performance with regards to preparing for climate change. It suggests guidance to next steps in an adaptation programme. The interactive tool takes account of existing programmes and strategies and highlights areas which may need further development, according to their framework.

PACT has been tested in a wide range of sectors both in the UK and internationally. It has been adapted to be used by UK Reporting Authorities to prepare their reports and should allow for easier analysis by policymakers when considering different industries.

8.2.1 PACT Framework

Figure 8.2.a shows the PACT climate change resilience levels. These levels increase in complexity and capacity with the most resilient and well prepared organisations being ranked towards the higher levels. According to the PACT creators, most organisations of any size would be assessed as active at the first and second levels of response: *"core business focused*" and *"stakeholder responsive*".

Figure 8.2.a: PACT levels of preparedness

Defining how organisations perform at the highest level, Response Level 6: *"champion organisation",* is still work in progress since few organisations have reportedly managed to consistently operate at this level. Following successful completion of the PACT survey, participants are rated for resilience levels in a number of key categories. These are:

- Awareness
- Agency
- Leadership
- Agents of Change
- Working Together
- Learning
- Managing Operations
- Scope and Coherence

- Expertise and Evidence

For more details on the criteria and pathways analysis, refer to the website.[3]

8.2.2 Veolia Water Central PACT Performance

Veolia Water Central has been rated at between response level 3 and 4, which according to the evaluation method, indicates that climate change is becoming embedded in our business model. The evaluation has identified that we should be aiming to operate at response level 5, a level rarely achieved, classifying us as a leading organisation.

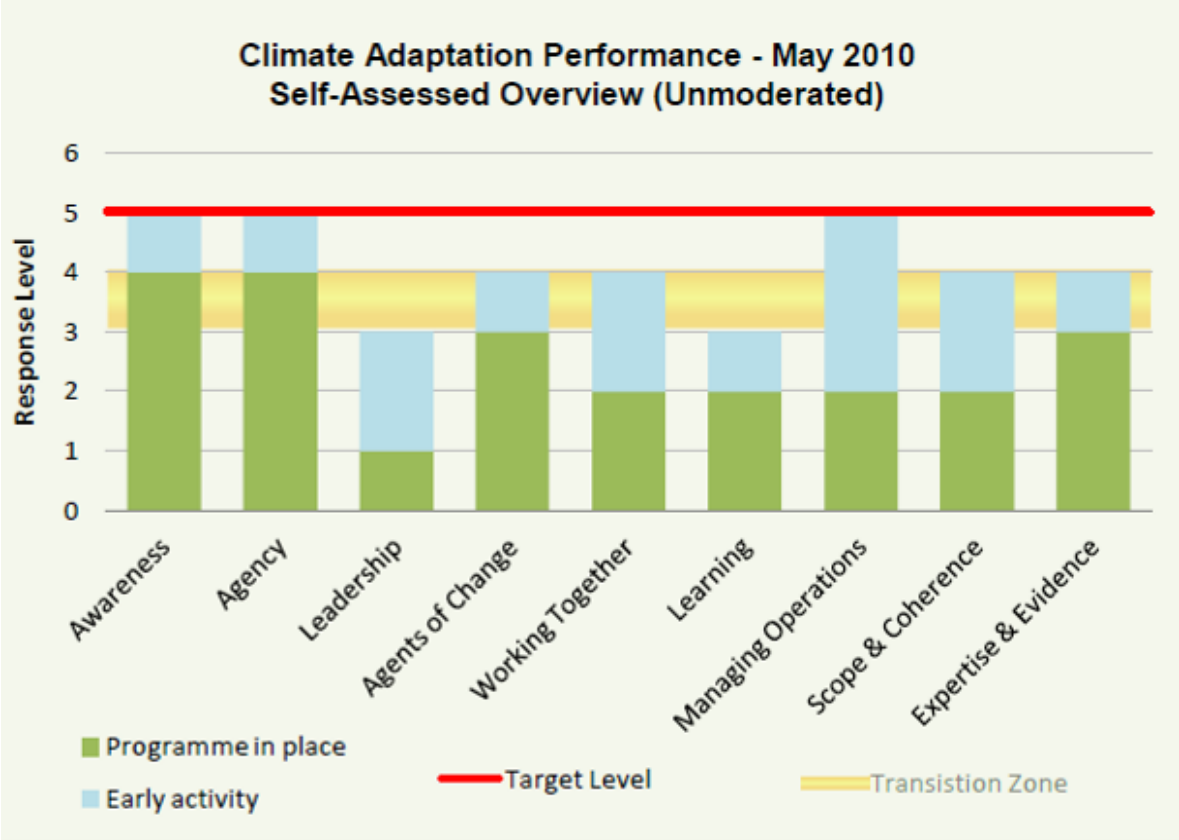
Our evaluation shows that we are a leading organisation when it comes to climate adaptation, and have been rated as "*efficient management*". With some guided effort from the findings of the PACT review, we hope to accelerate our efforts to become *"strategically resilient"* as shown in Figure 8.2.b.

Figure 8.2.b illustrates the performance overview from the PACT self assessment procedure for Veolia Water Central. The green areas represent where our current response level on adapting to climate change is solid. Any lighter blue areas represent where there are indications of early activity. While the areas of early activity are not yet solid at the higher level, these represent signs of where the organisation is beginning to move ahead.

Of particular note is the assessment for leadership see in Figure 8.2.b. The PACT assessment is lower than expected in the absence of specific policies, objectives, targets and communications on climate change adaptation whereas our approach, which reflects on statutory obligations and is supported by our Board, is to evaluate all risks that may affect the services we provide to customers. We consider this a more robust approach but have nevertheless found the PACT process helpful in challenging the way we embed climate change into our organisation.

[3] http://www.alexanderballard.co.uk/projects.php?id=12

Figure 8.2.b: Veolia Water PACT performance



As we would expect, we have mature systems and processes in place which are reflected in the higher scores for expertise and awareness etc. We recognise the challenge of moving from understanding the potential consequences of climate change from a theoretical model to specific action plans. We recognise the opportunity to further develop our risk assessment methodology will as assist in increasing our levels of performance in some of the other areas.

The evaluation from the PACT survey supports the feeling that the water industry is well prepared for the risks of climate change and that our organisation specifically is in a position to sufficiently adapt.

8.3 Moving Forward

Going forward we will continue to address our priority risks outlined in this report. Through periodic development of our associated Plans, we will monitor environmental changes over time and modify our action plans as appropriate to ensure we can guarantee our business functions across our planning horizon. Our risk assessment methodology may also change depending on our monitoring outcomes.

We will continue to develop our evidence base with others and ensure that our assets and operations are sufficiently resilient to the effects of climate change. As a water company, our performance is intrinsically linked to the environment and therefore a changing climate is of particular importance to us.

If we are able to overcome the barriers mentioned, and remove many uncertainties, it is possible that we will be able to accurately quantify the effect of climate change over and

above general changes in our region and prepare adaptation actions accordingly. In order to do this we will work closely with our regulators to ensure our adaptation actions remain appropriate and that we can guarantee service to our customers beyond our planning horizon.

This report has shown that we have a good understanding of the consequences of climate change on our operations and have developed well evidenced and independently verified adaptation programmes. Despite having not completed a specific risk assessment to assess the effects of climate change, our planning approach and methodology is verified to be appropriate by our regulators. We feel that we are as well prepared as is realistically possible until the end of our planning horizon at least and that our customers and stakeholders have every reason to be confident in our ability to maintain our excellent position within the industry.

A. APPENDIX A - CRANFIELD EVALUATION FRAMEWORK: KEY ATTRIBUTES CROSS REFERENCE

This Appendix allows for easier cross reference between the key attributes and sub-attributes of the Cranfield evaluation framework. The Cranfield evaluation framework specifically covers only the risk assessment component of the adaptation reports.

The references provided in this appendix are by no means exhaustive and the main report should be consulted for full details. Assessing the risks as a result of a changing climate and preparing adaptation actions is an integral part of our business operations and so therefore our risk assessment methodology, results and monitoring processes are integrated in all of our decisions. Our approach differs between many of our identified risks and so the main report should be consulted and considered on a risk by risk basis.

Table A: Attributes and sub-attributes of the evaluation framework and relevant cross reference within main report

Key Attribute	Sub-Attribute	Report Reference
1. Climate change risk assessment is a clear component of corporate risk appraisal.	1.1 Climate change demonstrably a key consideration in corporate planning and processes of the Reporting Authority.	2.2, 4
	1.2 Reporting Authority presents a clear analysis of climate risks on business operations for specified periods into the future and includes high priority climate related risks and timescales.	4
	1.3 Adaptation plan is clearly embedded in the core of the Reporting Authority's business.	5
	1.4 Reporting Authority includes some prior evaluation of how its climate change risks impact upon or are affected by stakeholders.	4.1, 4.2, 4.3
	1.5 Reporting Authority considers the existing policies and procedures related to climate impacts, and the effect the weather has on operations and achievement of the organisation's strategic objectives.	4.1, 4.2, 4.3
2. Climate change risk assessment enables the Reporting Authority to make evidence based decisions on adapting to climate change	2.1 Reporting Authority adopts a conceptual risk management framework for organisational, rather than locational risks.	3
	2.2 Reporting Authority identifies the key climate variables and their potential impact on the organisation.	4.1, 4.2, 4.3
	2.3 Reporting Authority provides clear criteria for likelihood and consequence that are appropriate and specific to their organisation.	3.1.2
	2.4 Reporting Authority's risk assessment quantifies, or otherwise estimates or characterises the impact and likelihood of risks occurring at various points in the future.	3.1
	2.5 Reporting Authority presents all the	Appendix C

	organisation's strategic risks from climate change on a likelihood/consequence matrix, where possible including the climate thresholds above which climate change poses a threat to the organisation. Where it is not possible, the Reporting Authority should set out how it will investigate thresholds.	
	2.6 Reporting Authority considers short, medium and long term risks of climate change disaggregated into different locations where appropriate, and includes an assessment of the level of confidence in these calculations.	4

3. Demonstrable use of relevant and appropriate data, information, knowledge, tools and methodologies	3.1 Reporting Authority adopts the latest set of UK Climate Projections (currently UKCP09) or other appropriate scenarios or climate information.	4.1.1, 4.1.4.1.1, 4.1.4.2.1, 4.2.1, 4.3.1.1
	3.2 Reporting Authority demonstrably assesses using the best evidence suitable to organisational need.	4.1.1, 4.1.4.1.1, 4.1.4.2.1, 4.2.1, 4.3.1.1
	3.3 Reporting Authority's risk assessment includes consultation with interested parties or stakeholders.	3.1

4. Climate change risk assessment and adaptation measures explicitly consider uncertainties.	4.1 Reporting Authority's risk assessment includes a statement of the main uncertainties in the evidence, approach and method used in the adaptation plan and in the operation of the organisation.	6
	4.2 Reporting Authority's adaptation responses explicitly account for uncertainties and interdependencies of actions, including the actions of others on the adaptation plan.	5
	4.3 Reporting Authority's adaptation plan includes a clear statement of assumptions which are well evidenced.	5, 6

5. Climate change risk assessment generates priorities for action	5.1 Reporting Authority provides priority areas for action that are demonstrably linked to the development of a risk based adaptation plan	5
	5.2 Reporting Authority's adaptation plan includes a detailed action plan covering its priority areas. This should ideally include timescales, resources and responsibilities and be included in the report.	5
	5.3 Reporting Authority's risk management actions are targeted to demonstrably reduce risks to a defined level of residual risk	3, Appendix C
	5.4 Reporting Authority's adaptation plan is subject to appraisal against sustainability principles, and specifically to an appraisal of	5

	costs and benefits.	

6. Climate change risk assessment identifies opportunities	6.1 Reporting Authority's risk assessment allows an evaluation of net benefits and/or opportunities arising from the impacts of climate change	8

7. Clear demonstration of flexible adaptation measures	7.1 Reporting Authority's adaptation plan includes strategies to deal with the level of quantified risk and retains flexibility over which future course of action to follow as knowledge improves and projections change.	5
	7.2 Reporting Authority's adaptation plan includes a statement of the barriers to implementation and a means for overcoming these.	7

8. Monitoring and evaluation of adaptation effectiveness	8.1 Where possible, the Reporting Authority's report shows progress already made against its adaptation plan.	5
	8.2 Reporting Authority makes clear provision for the evaluation of the effectiveness and viability of its adaptation plan.	5, 8
	8.3 Reporting Authority makes clear provision for monitoring thresholds, above which climate change impacts will pose a risk to the organisation, and their incorporation into future risk assessments.	5, 8
	8.4 Reporting Authority makes clear provision for the monitoring of residual risks from climate change on the organisation and its stakeholders.	5, 8
	8.5 Reporting Authority offers evidence that the production of the risk assessment and adaptation plan has led to a change in the organisation's management of climate risks.	8

B. APPENDIX B - STATUTORY GUIDANCE TO REPORTING AUTHORITIES: BOX 2 CROSS REFERENCE

This Appendix allows for easier cross reference between Box 2 of the Defra Statutory Guidance (*Adapting to Climate change: helping key sectors to adapt to climate change)* and the main body of this report. The statutory guidance to reporting authorities has been issued by the Secretary of State to reporting authorities under powers contained in the Climate Change Act 2008. Its purpose is to provide reporting authorities with guidance and structure when assessing risks due to climate change and developing adaptation actions. Box 2 of the guidance is a summary of what the Secretary of State expects to see on receipt of the completed report.

Veolia Water Central's report is of a very similar structure to that laid out in Box 2 and that of the Executive Summary from the same guidance document. As with Appendix A, many of the themes addressed in this table are discussed throughout the entirety of the main report.

Table B: What to include in a report according to Box 2 of the statutory guidance and relevant cross reference within main body of report.

Attribute	Sub-Attribute	Report Reference
1. Functions impacted by climate change	a. What are your organisation's functions, missions, aims and objectives?	2.1, 2.2
	b. Which of these will be affected by the current and possible future impacts of climate change?	2.2
	c. Have you assessed the climate thresholds above which climate change and weather events will pose a threat to your organisation? If so what were the main results?	4
	d. Who are your organisation's key stakeholders? Do you need to assess the impacts of climate change on them?	2
2. Approach	a. What evidence, methods and expertise have you used to evaluate future climate impacts? List sources and references.	4
	b. How do you quantify, or otherwise estimate or characterise the impact and likelihood of risks occurring at various points in the future?	3
	c. How have you evaluated the costs and benefits of proposed adaptation options?	5
3. **Summary of risks which affect**	a. List all the organisations' strategic risks from climate change on a likelihood/consequence	Appendix C

functions, mission, aims, and objectives	matrix – including thresholds where applicable.	
	b. What short and long term impacts of climate change have you identified and how are each factored into the adaptation programme? Quantify the likelihood and consequences as far as possible (including an assessment of the level of confidence (e.g. high/medium/low) in the calculations) and disaggregate these risks to different locations where appropriate.	4
	c. What are your high priority climate related risks and why (stating level of impact to business, likelihood, costs and timescales)?	4.1, 4.2, 4.3
	d. What opportunities due to the effects of climate change which can be exploited, have been found?	8.2

4. Actions proposed to address risks	a. What are the adaptation actions for the top priority risks (stating timescales)?	5.1, 5.2, 5.3
	b. How will the adaptation actions be implemented (stating level of responsibility, investment and timescales)?	5
	c. How much do you expect these adaptation measures to cost and what benefits do you anticipate will result from them?	5
	d. How much do you expect them to reduce risk by, and on what timescales?	5
	e. How will you ensure the management of climate change risks is embedded in your organisation?	8

5. Uncertainties and assumptions	a. What are the main uncertainties in the evidence, approach and method used in the adaptation programme and in the operation of your organisation?	6
	b. What assumptions have been made when devising the programme for adaptation?	6

6. Barriers to adaptation and	a. What are the barriers to implementing your organisation's adaptation programme?	7

interdependencies	b. How will these barriers be addressed?	7.1, 7.2, 7.3, 7.4
	c. What/who are the interdependencies (including the stakeholders stated in response to question 1d)?	7.4

7. Monitoring and evaluation	a. How will the outcome of the adaptation programme be monitored?	5
	b. How will the thresholds, above which climate change impacts will pose a risk to your organisation, be monitored and incorporated into future risk assessments?	5, 8
	c. How will the residual risks of impacts from climate change on your organisation and stakeholders be monitored?	5, 8
	d. How will you ensure that the management of climate change risks is firmly embedded in your organisation?	8
	e. How will you enable your management of climate change risk to be flexible?	5, 8
	f. Has the production of this report led to a change in your management of climate risks?	8.2

C. APPENDIX C - LIKELIHOOD/SEVERITY MATRIX FOR IDENTIFIED CLIMATE CHANGE RISKS

Without Controls in Place

SEVERITY LIKELIHOOD	Low (1)	Quite serious (2)	Serious (3)	Very Serious (4)
Very High (4)				
High (3)			• BURST RESULTING IN LOSS OF SUPPLY DUE TO GROUND MOVEMENT	•
Medium (2)		• INCREASED DEMAND	• REDUCED GROUNDWATER SUPPLY • FLOOD RISK	• WATER QUALITY FAILURE
Low (1)			• REDUCED SURFACE WATER SUPPLY • ADMINISTRATIVE RISKS (unable to access site) • REDUCTION IN FINANCIAL RESILIENCE RESULTING FROM REGULATORY CHANGE (not specifically as a result of climate change)	

With Controls in Place

SEVERITY LIKELIHOOD	Low (1)	Quite serious (2)	Serious (3)	Very Serious (4)
Very High (4)				
High (3)		• BURST RESULTING IN LOSS OF SUPPLY DUE TO GROUND MOVEMENT		
Medium (2)		• REDUCED GROUNDWATER SUPPLY • INCREASED DEMAND • FLOOD RISK • WATER QUALITY FAILURE		
Low (1)		• REDUCED SURFACE WATER SUPPLY • ADMINISTRATIVE RISKS (unable to access site) • REDUCTION IN FINANCIAL RESILIENCE RESULTING FROM REGULATORY CHANGE (not specifically as a result of climate change)		